Showing how many useful arts are practised.

Mechanical Industries Explained

With illustrations.

By [illegible] Webb, F.R.S.S.A.

[illegible] Johnston, Edinburgh and London.

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SHOWING HOW MANY USEFUL ARTS ARE PRACTISED

WITH ILLUSTRATIONS

BY

ALEXANDER WATT

AUTHOR OF "SCIENTIFIC INDUSTRIES," "ELECTRO-METALLURGY," ETC. ETC.

CARVING IRISH BOG-OAK.
ETCHING.
GALVANIZED IRON.
CUTLERY.
GOLD-BEATING.
BOOKBINDING.
LITHOGRAPHY.
JEWELLERY.
CRAYONS.
BALLOONS.
NEEDLES.
LAPIDARY.
IRONFOUNDING.
POTTERY AND PORCELAIN.
TYPEFOUNDING.
BREAD-MAKING.
BRONZE-CASTING.
FILE-MAKING.
OR MOULU.
PAPIER-MACHÉ.

ETC. ETC. ETC.

W. & A K. JOHNSTON
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PREFACE.

APART from our ordinary studies or pursuits, it is undoubtedly an advantage to have some "hobby," or means of recreation, other than those which are too frequently adopted for the mere purpose of "killing time." While there are some whose mental inclination leads them in the direction of philosophic science or literature for their recreative pursuits, there are many whose taste leans towards those of a more mechanical nature. In all grades of society, from the highest to the more humble members of the community, the vast field of mechanical art has been explored for the purposes of intellectual enjoyment.

Moreover, the pleasure to be derived from making or constructing mechanical objects is not only a most agreeable pastime, but the work, if creditably executed, remains as a testimonial to individual labour and skill, and the simple title HAND-MADE carries with it a history of patience, perseverance, and industry which should entitle it to a high rank in human estimation.

Those who may have no desire for a more intimate acquaintance with mechanical operations than may be gleaned by reading, will, it is hoped, find in these pages sufficient information concerning some of our important mechanical arts to interest them, while, at the same time, it has been the author's aim to render the work acceptable to the rising youth of both sexes as a source of useful information and instruction.

CONTENTS.

CARVING IRISH BOG-OAK.

ALTHOUGH the interest which attaches to the substance known as Irish bog-oak, or "bog-wood," is naturally more keen in the Sister Isle than in our own portion of the United Kingdom, it is probable that a better acquaintance with this remarkable product of nature would kindle at least a fair amount of interest here if its useful applications were better known. The bogs of Ireland, besides yielding turf or peat of most excellent quality for fuel, are remarkable for the large quantity of semi-petrified timber which lies beneath their surface, apparently undergoing by slow degrees the process of conversion into coal. Large quantities of oak, as black as ebony, and in a high state of preservation, had been dug out of the Bog of Allen and other bogs; but no specific use was made of it, we believe, until some forty or fifty years ago, when it occurred to an ingenious old soldier named M'Guirck to utilize it in making certain ornamental articles, such as brooches, paper-knives, shamrock studs, etc. etc.

It was many years after the introduction of bog-oak carving, however, before the art became fully developed; and for a long time it was confined chiefly to the hands of M'Guirck's successor, a man of much ingenuity and skill, by whom many fine specimens of exquisite carving were produced, and which were readily, and even greedily, secured by the more gifted and appreciative of the Irish

nobility and gentlefolk of the time, whilst many illustrious visitors to the city of Dublin availed themselves of the opportunity to possess at least one specimen of the carver's work. As time progressed, however, so did the "whittlers" in bog-oak increase and multiply; and by the time the Rebellion of 1848 had culminated in the expatriation of Smith O'Brien and the other leaders of the Young Ireland party, at least half-a-dozen fresh bog-oak carvers appeared in the field; and from that period the number steadily increased, until, as is generally the case, the art became somewhat overdone. Bad workmanship, accompanied by the frequent substitution of ebony for bog-oak, caused the pretty art to lose its individuality and its integrity at the same time. We have a pleasing remembrance of the great interest which many of the leading aristocracy of Ireland took in the manufacture of bog-oak ornaments, after the political disturbances referred to had subsided. The late Master of the Rolls for Ireland, Mr. T. B. C. Smith (or "Alphabet Smith," as he was humorously called), a man of exquisite taste and judgment, suggested many interesting designs from the antique, which were afterwards faithfully duplicated in bog-oak, to the great delight of all who beheld them. Nor was bog-oak carving, at the time we mention, confined to professional hands alone, for many amateurs, including the fair sex, sought recreation in the pleasing art, amongst whom may be mentioned the accomplished daughters of the late Earl of Howth.

Bog-oak is an exceedingly agreeable substance for carving purposes, being both hard and tough. The finest specimens are intensely black. In structure it possesses all the characteristics of ordinary oak, and may readily be distinguished from ebony (or "African bog-oak," as it is termed),

when substituted for the real article, by its open grain and cellular structure.

An important feature in bog-oak carving, when applied to objects of moderate dimensions, such as brooches, snuff-boxes, paper-knives, etc., is the small number of tools required. This is a great advantage to those who might desire to learn the art, but who may possess no previous knowledge of carving in wood. There are few mechanical arts in which such pleasing results may be obtained with so few appliances; but as several of the tools required for special purposes are of a peculiar form, and may not be obtainable at the ordinary tool-shops, instructions will be given to enable the student either to make such tools himself or to have them made to his order.

As a preliminary effort let us first select a piece of bog-oak free from flaws, and as close in the grain as possible. Suppose we commence with a "view brooch," as it is termed—that is, an oval brooch with a landscape or rustic scene carved on one side, with a plain or ornamental border, representing, as it were, a picture in a frame. The first thing to do is to cut a slice of the wood end-way—that is, transversely—with a tenon or circular saw, about $\frac{1}{4}$ of an inch in thickness. With a lead pencil sketch an oval outline, say $2\frac{1}{2}$ inches long by $1\frac{3}{4}$ wide, at the best or soundest part of the wood. Having done this, a second oval is to be drawn *inside* the former, leaving a space of about $\frac{1}{4}$ of an inch between the two. The view or scene is to be sketched in outline within the inner oval. Ruins of old castles and other similar structures look exceedingly well for this purpose, and are by no means difficult, especially to those who have some knowledge of drawing.

Having so far designed the work, it will now be neces-

sary to consider what tools will be required to carry the operation through all its stages: as we have said, the tools are not very numerous, but those we are about to mention are indispensable. One or two small gravers; a lozenge-shaped graver; several small sculpters; several keen-cutting half-round files; two chisels, one $\frac{3}{16}$ of an inch, and one $\frac{1}{4}$ of an inch; an American drill-stock and drills; a pair of pliers; glass-paper; one $\frac{1}{8}$-inch gouge; small tenon saw; and oilstone for sharpening tools. An instrument termed the "dog-legged tool" is very necessary for some purposes, and since it may not be easily procurable we will attempt to describe an easy way of making

it. Take a piece of flat, or even round, steel about 5 inches long and $\frac{1}{8}$ of an inch in diameter, and having made it red-hot at one end, bend it at a right angle with the pliers, or in a vice, about $\frac{3}{4}$ of an inch from the point. Make it red-hot again, and bend once more at a right angle about $\frac{5}{8}$ of an inch upward from the former bend. If the steel employed be flat, a sharp face similar to that of a chisel is to be filed on the upper surface of the first bend, and the haft is to be slightly pointed and driven firmly into an ordinary graver-handle. If round steel is employed, the point must be hammered flat like an ordinary brad-awl, and faced as before.

The next thing to do is to harden and temper the point, which is readily done thus: Make the point as hot as

fire will make it, and *instantly* plunge it into cold water; it is thus *hardened.* The face of the tool should then be made bright by rubbing on a piece of emery-cloth moistened with oil, to remove oxide from the surface, and the face then rubbed on the oilstone; now place it over the flame of a lamp, applying the heat at a spot about 1 inch from the point; the moment the *face* of the tool assumes a straw-coloured tint, it is to be quickly plunged into cold water, when the tool will be *tempered*, and after being properly sharpened on the oilstone is ready for use. This is a very important and useful tool for producing jagged or rough surfaces in certain parts of the work to be described hereafter.

The cutting tools employed in bog-oak carving are to be used after the fashion adopted by engravers—that is to say, the handle is to be placed in the palm of the hand, and the blade, resting on the thumb, is to be propelled by the motion of the hand. A very little practice will enable the beginner to acquire the knack of handling and guiding the tools properly, upon which much of his success as a carver will depend. It is a good plan to practise the manipulation of the gravers by making straight and curved lines upon pieces of hardwood (boxwood, for instance) until the hand becomes accustomed to the movement required to force the tool forward from the palm of the hand. The gravers, chisels, and sculpters must be well sharpened on the oilstone before use, and care must be taken to preserve the form of face given to them by holding the tool at a proper angle when applying it to the oilstone.

Having prepared the outlined design, the next thing to do is to cut through every pencil-mark with the graver,

not too deeply, beginning with the outer oval, and so on until the sketch is completely traced with the graver.

It is not necessary to do more than sketch an outline at first, as the *detail* must be filled in according to the character of the picture to be represented, in doing which much of the wood must be cut away to produce the desired effects of perspective, light and shade, etc. This is done by drilling a series of holes *through the wood* at the parts which have to be cleared away as not being part of the design. The object of these perforations is to render it easy to cut away with the small chisel all the wood between the border and the outer line of the sketch. Those who have not the advantage of a lathe may use the American drill-stock for the above purpose. It is well to drill as many holes as possible, by which means there will be less liability of splitting when cutting away the superfluous wood with the chisel. This must be done very cautiously at first until an opening is made, otherwise the wood may split at its weakest part. Only ordinary care is necessary to avoid this. As soon as an opening is effected from front to back, the chisel may be applied more freely until the open spaces (representing the sky) are perfectly clear. Those parts which cannot be cleared by aid of the smaller chisel must have a narrow sculpter applied to them. Having thus far progressed, it will be advisable to cut away all the superfluous wood *outside* the oval margin. This may be readily done (keeping the object flat on a wooden block or bench) with the chisel, which must be held vertically, and only small fragments of the wood removed at a time, care being taken not to approach too close to the marginal boundary. A keen-cutting file will easily finish this part of the work, if great

care be exercised to preserve the perfectness of the outline.

To give additional effect to the border it is a good plan to bevel it from the picture, outward, which may be done either with a chisel, and subsequent smooth-filing, or with a small rasp, followed by a keen file. The border may be bevelled to the extent of about $\frac{1}{16}$ of an inch below the

outer edge. Before proceeding to carve the view, the border, outer edge, and back may be rendered smooth by means of glass-paper, finishing with the finest paper obtainable, or with paper which has been frequently used.

It will now be necessary to turn our attention to the view or scene to be represented, and the accompanying outline sketch of Waterloo Bridge, Connemara, will not be a difficult subject to treat. First drill a series of holes in what we may call the "sky" part of the picture; then with the smaller chisel carefully cut away all the wood between the

outline of the picture and the inner margin of the border, taking care not to cut too close to the outline at first. When all this superfluous wood is cleared away, cut down the tower to the depth of about $\frac{1}{16}$ of an inch up to the capital, which must project; next cut the bridge $\frac{1}{32}$ below this, so as to throw it farther back; then cut the archway on the right of the tower at the angle depicted. The pointed rocks on the left of the picture may then be produced by sharp, irregular cuts with the flat and round sculpters, and lozenge graver, used alternately, to give the effect of perpendicular needle-shaped rocks of *irregular* heights. The water may next be attempted by taking the dog-legged tool and working it backward and forward with a rocking motion, commencing at the lower line and working the tool gradually upward to the base of the bridge. The object being to produce a wavy or water-like effect, the tool must be applied as directed all over the space representing the water. It will be necessary, in order to give the effect of perspective, to increase the pressure upon the handle of the tool, so as to cut deeper and deeper when nearing the bridge. A few short horizontal cuts with the graver upon the surface of the water will give it a still more wavy appearance, if carefully done. The boulders, or large stones, on either side of the water may readily be formed by cutting facets with the chisel thus: First make a clean diagonal cut to the right, then a similar cut to the left, and a third cut above; now follow this up by making a series of such blocks or stones of various sizes, diminishing in the distance—that is, towards the bridge. When this is done neatly, and with due regard to perspective and ruggedness, a very pleasing relief is given to the rest of the picture. The tree on the right of the tower may be formed

by first cutting the stem down about $\frac{1}{16}$ of an inch, and then, with the dog-legged tool, render the upper part rough by working the tool from bottom to top, and then from side to side; now, with the same tool, dig out a portion of the wood here and there to give a tree-like form.

The arch of the bridge may next be formed by clearing away sufficient wood to leave the arch open; the bridge may, if necessary, be cut still deeper (taking care not to cut through to the back) to increase the distance, and the stonework of the bridge may be represented by short cuts with the graver. In order to add to the ruggedness of the old bridge, the surface may be scraped over with the point of a broken file applied in a horizontal position. The tower should also be roughened by scraping or scratching with a broken file, and when this is done, the cross, or window, may be cut with the graver, and the castellated capital formed by aid of the small square sculpter. Having progressed thus far, the picture should be carefully examined, and all defects of drawing rectified. Bearing in mind that the tower is round, both the base and the capital must be neatly rounded to give the desired effect, and to aid the general effect of the picture.

The border of the brooch, as we will now call it, is our next consideration, and this may be formed in many designs, one of the neatest being that shown in the sketch. After carefully filing the border to the proper shape, the face and edge may be rendered still smoother by means of very fine glass-paper. The scroll is readily formed by gently heating a small gouge, or the butt-end of an ordinary steel pen, fixed in a cork, and pressing this into the wood at the end of each curve, giving the tool a slight twist so as to form the turn of the scroll, as in the sketch. When this is

done, a series of cross cuts made with the graver will complete the design, unless the carver's ingenuity suggests additional adornment.

The border of the brooch may be ornamented in many other tasteful ways, and as an easy design for a beginner the following will commend itself. It will be necessary, however, to make a small tool for this purpose; but as this is a very easy task, we will describe in a few words the way to make it. Take a piece of round steel wire about $\frac{1}{8}$ of an inch in diameter and 4 inches long; file a flat surface at one end, and slightly point the opposite end, so that it may be fixed in a handle. With a fine, small, half-round file cut three grooves from a little below the end up to its face, the grooves being equidistant. If the edges of the figure thus left on the face of the tool be neatly rounded, three leaves of a shamrock will be formed. By pressing this upon a piece of paper the form of the tool (if it has been properly made) will leave an impression perfect in its proportions. Now in employing this tool, it merely requires to be made moderately hot over a gas-flame or candle, when, if it is pressed on wood, it will leave a clear and well-defined figure of the shamrock. To ornament the border with this tool stamp the design at equal distances (about $\frac{1}{2}$ inch apart) round the border, each alternate impression being to the right and the others to the left. When all the impressions are made they require to be linked together by a stalk traversing the entire border. This must be done with the graver, and it merely requires a little taste and careful handling of the tool to produce a graceful effect. From the main stalk, or stem, alternate stalklets (so to speak) may be traced, uniting the shamrocks with the main stem. The reader will soon find

that not only is this a very agreeable field for the exercise of artistic taste and judgment, but that in reality it requires but a very moderate amount of study and practice to produce very pleasing results.

When the view brooch is finished, a simple operation will give it a brilliant and very pleasing appearance. Brush it well all over with good, strong, black ink made hot, to which a little sugar may be added. Set it aside for a short time, and again apply the ink. When nearly dry a large soft brush must be applied briskly until the whole surface of the wood, back and front, has been rendered perfectly bright. A very good solution for this purpose may be made with logwood-chips, nutgalls, sulphate of iron, and a little gum and sugar. Into this solution, after being boiled and allowed to cool a little, the bog-oak carving may be immersed for a short time, and then treated as before.

The view brooch, being now complete, may be mounted by any working jeweller, who will affix a joint catch and tongue at the back for a very moderate sum.

As an additional ornament to the shamrock border previously described, an acorn pattern, placed alternately with the shamrock, looks exceedingly well. The acorn stamp for making the necessary impressions may be easily filed out of a piece of soft steel wire. Scrollwork borders are also highly suitable for the ornamentation of the framework of the view brooch, and the coil of the scroll may be readily formed by means of a small gouge made slightly hot. By pressing the gouge gently into the wood, and turning the hand slightly, a very neat and simple coil may be formed, which can be converted into a continuous scroll by means of the ordinary graver. It

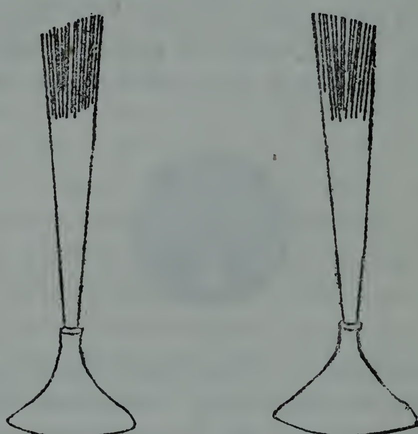
is better to trace a design in pencil upon the border before applying the necessary tools, by which means the accuracy of the design may be ensured. Leaf patterns also form very pretty borders for view brooches; in fact, there are so many appropriate and graceful designs which may be applied to this part of the carving, that the taste of the carver will readily suggest such as will meet his requirements.

Shamrock studs are not only very characteristic, but form very pleasing ornaments for the shirt-front. These studs are by no means difficult to make, and those who have the advantage of a lathe, and the knowledge of its use, can easily turn the studs ready for the subsequent operation of carving. Those who have not a lathe, however, may take their selected piece of bog-oak to an ordinary hardwood turner, who will have no difficulty in putting it into the required form. In turning bog-oak studs, the lower part, or button, should be of the same size as in the ordinary shirt-studs, with a pillar or stem of the usual height. The top, however, should be a little larger, say nearly twice the diameter of the button, bevelled downward at its edge, and flat at the top. Having obtained the studs from the turner, take one of them in hand, and with a blacklead pencil trace a bold, straight line across the flat face of the stud, exactly across its centre. A second line is to be traced in the opposite direction, so as to form a cross, reaching from edge to edge. The spaces between the cross are thus disposed of: One of them is to be selected, and a curved stalk is to be traced, say, $\frac{1}{16}$ of an inch in width. This stalk will be just below the upper segment of the circle, and this, with the two lateral divisions, will form the three leaves of the shamrock. Having

proceeded thus far, it will now be necessary to cut through the pencil outlines with a graver. The next operation is with the small $\frac{1}{4}$-inch chisel to cut away the superfluous wood. The stalk may be attacked first by removing the wood from each side of the engraved line, taking care not to cut away more than is necessary. Now, with the same chisel cut between each segment at its outer edge, so as to slightly round each of these divisions or leaflets of the shamrock. A very little judgment will show how much of the wood need be removed to leave the form of a leaf in each division. Again take the graver in hand, and cut a line from the outer centre of each division or leaflet down to

the centre of the stud. When this is done, the form of the leaf will begin to show itself. The next thing is to cut down with the $\frac{1}{4}$-inch chisel between each subdivision of the leaflets, from the outer edge to the engraved line, in each case. The cut is to be made cleanly, about $\frac{1}{16}$ of an inch deep at the engraved line, leaving the outer edge of the stud of its original height. When one side of the leaflet is thus cut down, the opposite side is to be cut in a similar manner, and so on until each leaflet appears sunken towards the centre. The stalk is now to be cut down to a little below the leaflet above it. With a keen but fine file now file the stalk and leaflets into proper shape, observing the most perfect accuracy in this detail (see engraving).

In order to give the characteristic lines to each subdivision of the leaflet two tools are necessary, one for the left and the other for the right handed cut. These tools may be thus described: Take a piece of flat steel about $\frac{5}{16}$ of an inch wide, $\frac{1}{16}$ of an inch in thickness, and about 3 inches long. As this tool requires to be fitted into a handle, it will be necessary to file away sufficient metal at one end to enable it to be fixed in an ordinary graver-



handle. The cutting end of the tool must now be filed obliquely, so that one edge of the tool will be about $\frac{1}{4}$ of an inch below the other. A series of deep lines are now to be cut with a graver, commencing at the upper edge or point of the tool, and passing downward towards the haft, to the extent of, say, $\frac{3}{4}$ of an inch. These cuts should be rather deep, perfectly straight, and extend the whole width of the tool. Turning the tool over, it is to be faced, chisel-like, by filing down to the proper angle. Now remove the

tool from the handle and place it in the fire. When white-hot plunge it into cold water; after being well rubbed on emery cloth, with the assistance of a little oil, the tool may be tempered by holding the haft in a gas-flame until the point assumes an orange tint. After cooling, rub the face of the tool on the oilstone until quite sharp. It is necessary to have, as we have said, a left and right handed veining tool for cutting shamrock leaves. To accomplish this the angles of the tools must be filed in opposite directions (see engraving).

In using the veining tools, hold the bog-oak stud firmly in the left hand, resting it upon the corner of a bench (or, still better, a projecting piece of wood such as jewellers employ), and having selected the proper tool, press it firmly into the wood, beginning with the half leaflet on the right of the stalk. The cuts are to be continued from the outer edge down to the engraved line in the centre of the leaflet. The tool must be used with firmness and a steady hand, so that the veins may appear perfectly sharp, distinct, and straight. The second tool is then to be applied in like manner to the other half of the leaflet, and so on until the veining is complete. The graver should now be again passed down the centre of each leaflet, so as to make a distinct partition between its two halves. As a final operation, the stalk should be bevelled from its upper surface downward by means of the chisel, and a curved line traced on the face of the stalk will relieve its flatness. The studs may be blackened and polished as before described.

Fly-studs may be very easily made in bog-oak from studs turned as suggested; and when well made, they not only form a pleasing ornament, but from their close resemblance to the notorious bluebottle, they often create a good deal

of merriment, by being mistaken for the lively original. To make the fly-stud, trace the outline of a fly on the face of a turned bog-oak stud of the size employed for the shamrock pattern. Now cut away superfluous timber as before, and trim the edges with a file. Having cut the head into the proper form, proceed to cut out the body, a little below the wings, being careful to give it the proper shape. The wings should next be cut and rounded at their extremities, and several lines cut in them with a graver to give the veined appearance of the wing of the fly. A small tool is now required to form the eyes. This consists of a small piece of steel wire, with a hollow scooped out at one end, and which when heated and pressed upon wood, will leave a raised button-like projection. This being applied while hot to each side of the head of the fly-stud, will form the eyes very readily. In making this tool, it is a good plan to take a piece of steel wire about $\frac{1}{8}$ of an inch thick, and having filed one end perfectly flat, the sculpter, or a pointed drill, will readily form the required hollow. When this is done take a fine file and file round the point, leaving a narrow margin round the hollow referred to. When the fly-stud, as far as carving is concerned, is complete, it will be necessary to drill three small holes on each side of the model for the insertion of the legs. Now take a piece of ordinary iron binding wire, cut it into six lengths of about $\frac{1}{2}$ inch each, and making one end of each piece of wire hot in the flame of a candle, apply a piece of shellac to the end of each. With another piece of wire, heated and dipped in shellac, apply this material to the interior of each hole in the model. By again heating the end of the six pieces of wire, and pressing them into the holes, they will become securely fixed when

cold. With a small pair of pliers bend each of the six pieces of wire into the proper form of a fly's leg, and the object is finished.

CASE-HARDENING.

When it is desired to impart a surface of steel to objects made of iron, either of the following methods may be adopted. Suppose the object to be treated is an iron key, for example. Let this be covered with grease, and afterwards well wrapped up in a piece of woollen cloth bound tightly on the key by means of thin iron wire. Now place the key thus prepared in the hottest part of a clear fire, and let it remain until all the woollen matter has burned away. The key is then to be withdrawn from the fire by means of a pair of tongs, and instantly plunged into cold water. The surface of the metal will thus have become converted into steel, and the article may be polished by means of fine emery-cloth and oil, and afterwards finished by polishing with powdered crocus.

In case-hardening iron tools and small objects required to be polished, the following method is practised on the large scale: The articles are placed in an iron box embedded in powdered charcoal; the box is then submitted to a brisk heat in a furnace—the process being termed "cementation"—and the articles are afterwards immersed in cold water, and subsequently polished.

Ferrocyanide of potassium is sometimes employed in the process of case-hardening. The iron article is first well polished, and is then made red-hot, and while in that state the part required to be hardened is sprinkled over with finely-powdered ferrocyanide of potassium.*

* See Scientific Industries, p. 76.

This salt becomes decomposed by the heat, and the surface of iron, after being quenched in cold water, becomes exceedingly hard, indeed so much so that a file produces no effect upon it.

If small articles, or portions of them, are first made red-hot, and then dipped into powdered prussiate of potash (ferrocyanide of potassium) for an instant, and finally dipped into cold water, the hardening effect is produced with perfect certainty and ease. Any small iron article may have a steel surface imparted to it by either of the processes mentioned with very little trouble to the operator.

BRONZE-CASTING.

The universal interest which attaches to those exquisite works of art known as *bronzes* will render a short description of the system adopted in their production interesting to many readers. The following is from the pen of an intelligent American writer :—

"Real bronze is an alloy of copper, zinc, and tin, the two latter metals forming a very small part of the combination, the object of which is the production of a metal harder than the pure copper would be, and consequently more capable of standing the action of time, and also less brittle and soft than zinc alone.

"The original statuette is generally finished in plaster. The manufacturer's first operation is to have it cut in such pieces as will best suit the moulder, the mounter, and the chaser, for very few bronze statuettes are cast all in one piece. Arms and legs are generally put on after the body is finished. The next operation is to reproduce the different parts of the figure in metal. For this the moulder

takes it in hand to prepare the mould. He begins by selecting a rectangular iron frame, technically termed a flask, large enough for the figure to lie in easily. To this frame, which is from 2 to 6 inches deep, another similar frame can be fastened by bolts and eyes arranged on the outside of it, so that several of these frames superposed form a sort of box. The workman places the plaster statuette, which is now his 'pattern,' on a bed of moulding sand inside the first iron frame. The sand used for mould-making is of a peculiar nature, its principal quality being due to the presence of magnesia. Only in one locality in the world is found the best sand, that is at Fontenay-aux-Roses, a few miles from Paris. This sand, when slightly damp, sticks together very easily, and is well fitted to take the impression of the pattern.

"Once the pattern embedded in the sand, the workman takes a small lump of sand, which he presses against the side of the figure, covering a certain portion of it. Next to this piece he presses another, using a small wooden mallet to ensure the perfect adhesion of the sand to the pattern. Each one of these pieces of sand is trimmed off, and a light layer of potato-flour dusted over both the pattern and the different parts of the mould, to prevent them from adhering together. In course of time the entire part of the pattern left above the first bed of sand on which it has been placed will be covered with these pieces of sand, which are beaten hard enough to keep together. Loose sand is now thrown over this elementary brickwork of sand, if it may be so called, and a second iron frame bolted to the first one to hold the sand together, which, when beaten down, will form a case holding the elementary sand pieces of the mould in place. The work-

man now turns his mould over, and removes the loose sand which formed the original bed of the pattern, and replaces it by beaten pieces, just as he has done on the upper side.

"We can now easily conceive that if the mould is opened, the plaster pattern can be removed, and that if all the pieces of sand were replaced as they were, we shall have a hollow space inside the mould which will be exactly the space previously occupied by the pattern. If we pour melted metal into this space, it will fill it exactly, and consequently when solidified by cooling, reproduce exactly the plaster pattern. For small pieces this will answer very well, but large pieces must be hollow. If they were cast solid the metal in cooling would contract, and the surface would present cracks and holes difficult to fill. To make a casting hollow it is necessary to suspend inside the mould an inner mould, or 'core,' leaving between it and the inner surface of the first mould a regular space, which is that which will be filled by the metal when it is poured in. This core is made of sand, and suspended in the mould by cross wires or iron rods, according to the importance of the piece. A method often used in preparing a mould, named by the French *cire perdue*, will help to illustrate this. The artist first makes a rough clay image of the figure he wants to produce. This will be the core of the mould; he covers it with a core of modelling wax of equal thickness, and on this wax he finishes the modelling of his figure. The moulder now makes his sand-mould over the wax, and when it is completed, by baking the mould in a suitable furnace, the wax runs out, leaving exactly the space to be filled by the metal. The celebrated statue of Perseus, by Benvenuto Cellini, was cast in this

way, and it is very frequently employed by the Japanese and Chinese. Sometimes flowers, animals, or baskets are embedded in the mould, and after the baking, the ashes to which they have been reduced are either washed or blown out to make room for the metal. This can easily be done through the jets or passages left for the metal to enter the mould, and through the vent-holes provided for the escape of air and gases.

"When the mould has cooled, it is broken to remove the casting it contains, and here is the reason why real bronze is so much more expensive than the spelter imitation. For each bronze a new sand-model must be made, while the zinc or spelter can be poured in metal moulds which will last for ever. In this way the pieces are produced with little more labour than that required to manufacture lead bullets. These pieces, of course, do not require the same expensive finish as the real bronzes. When the casting is taken out of the mould it goes to the mounter, who trims off, files the base true, prepares the sockets which are to receive the arms or other pieces to be mounted, and hands the piece to the chaser. The work of this artist consists in removing from the surface of the metal such inequalities as the sand-mould may have left, and in finishing the surface of the metal as best suits the piece. The amount of work a skilful chaser can lay out on a piece is unlimited. In some cases the very texture of the skin is reproduced on the surface of the metal. This mode of chasing, called in French *chairé*, and in English "skin-finish," is of course only found on work of the best class. Sometimes pieces are finished with slight cross touches similar to the cross-hatching of engraving. This style of finish, which is much esteemed by connoisseurs, is termed

'cross-riffled,' or *riboute*. After the chaser has finished his work, the piece returns to the mounter, who definitely secures the elements of the piece in their places.

"The next process is that of bronzing. The colour known as 'bronze' is that which a piece of that metal would take through the natural process of atmospherical oxidizement if it were exposed to a dry atmosphere at an even temperature. But the manufacturer, not being able to wait for the slow action of nature, calls chemistry to his aid, and by different processes produces on the surface of the piece a metallic oxide of copper, which, according to taste or fashion, varies from black to red, which are the two extreme colours of copper oxide. The discovery of old bronzes, buried for centuries in damp earth, and covered with verdigris, suggested the colour known as *vert antique*, which is easily produced on new metal by the action of acetic or sulphuric acid. In the fifteenth century the Florentine artisans produced a beautiful colour on their bronzes by smoking them over a fire of greasy rags and straw. This colour, which is very like that of mahogany, is still known as a Florentine or smoked bronze."

ANNEALING GLASS.

Baron Albert and Mr. J. M. A. Weyer's process consists in burying the articles to be annealed in powdered stone, plaster, lime, fireclay, etc., or in grease, oil, the fused nitrates of potash and soda—in fact, any liquid or solid capable of receiving the required heat, and remaining in a condition suitable for the process. By this means glass articles are not only rendered more capable of sustaining sudden transitions of temperature, but they are also

strengthened to a considerable degree. Thus champagne-bottles made by the processes at present in vogue are unable to sustain a higher pressure than thirty atmospheres, but when annealed by the new method, they will withstand fifty atmospheres. Lamp chimneys may also, when highly heated, be plunged into cold water without any danger of cracking. The method of embedding the articles in powder renders it possible to anneal at a very high temperature, which is impossible unless some means are provided for supporting the articles and maintaining their shape when reduced to the softened state necessary to secure perfect annealing. By the new process the articles are filled with the powdered stone or other substances, and are then placed in crucibles and completely surrounded with the pulverized substance employed, being covered to a depth of at least 2 inches. The crucibles are then subjected to a heat gradually increasing to 800° C., or even to 1000° C., in a suitable oven for from four to six hours, and are then slowly cooled, the operation lasting for twenty-four hours when the articles are thick. Where there is little danger of spoiling the shape of the articles the method of annealing by use of liquids gives similar results more rapidly and at a less cost. In carrying out this process two boilers are employed, so placed that the liquid can be run from the upper into the lower. If nitrate of soda is employed the temperature will be over 260° C. before the salt is melted, and the articles are then immersed in the cold state, and the temperature raised in that case to 300° C., the highest degree possible with nitrate of soda. They are then allowed to cool slowly, and when the temperature approaches 260° C., or solidification point, the nitrate is run off into the lower boiler, and a small fire is maintained

beneath the upper boiler to prevent the too rapid cooling of the glass. By this process the articles are said to be perfectly annealed without injury to the surface or the shape.

MORTARS AND CEMENTS.

The well-known cement called "mortar," so largely used for building purposes, is composed of quicklime, sand, and water. River or pit sand only should be used, and stone-lime in preference to chalk-lime for making the finest mortar. Since the stability of our dwellings depends greatly upon the quality of the mortar employed in brick-laying, it would be well if that ubiquitous individual, the much-dreaded District Surveyor, were in *all* cases to cast his terror-provoking eye upon the messes too frequently employed as binding material for bricks under the style and title of "mortar." It is true that while thus engaged, his valuable time would be less at the disposal of those who, without giving the formal notice and the formal fee, dare to erect summer-houses within so many feet of an ordinary dwelling-house.

Hydraulic mortar, or **Roman cement,** is employed in the construction of walls and piers which are exposed to water. For the purpose of making this cement certain qualities of limestone are employed, which contain in their composition silica, magnesia, alumina, etc. The native limestone is thoroughly calcined, and is afterwards reduced to a fine powder. When moistened with water a paste is formed which hardens under water, and resists the action of that element for an indefinite period.

The substance chiefly used in England for making Roman cement is that which is commonly called *cement-*

stone. It is found in the argillaceous strata which occur alternately with the limestone beds of the Oolitic formation on the coasts of Kent, Yorkshire, Isle of Wight, etc., and sometimes in London clay. The clay strata above the chalk sometimes yield the nodular concretions called *oolites*, or cement-stones; they are commonly of a yellow, grey, or brownish colour, and are sometimes composed of lime, magnesia, manganese, protoxide of iron, silica and alumina, or clay.

The stones are calcined in kilns, and afterwards ground to a fine powder, sifted, and finally packed in casks. When required for use, the cement is generally mixed with fine sharp sand, worked up into a thick paste with water, and used immediately, or before it has time to become hardened. The cement is much employed in the formation of embankments, and for protecting walls from the effects of moisture.

Portland cement, so called from the district in which the material is found, consists in calcining a mixture of limestone and argillaceous—that is, clayey—earth, and afterwards grinding and sifting the powder. It is necessary to exclude this cement from the air, otherwise it soon loses its power to set in a hard concrete mass after being mixed with water. Portland cement is much used in the preparation of "concrete," a mixture of the cement with small pebbles, slightly moistened with water. This cement may fairly be considered one of the most important aids to the construction of permanent buildings, more especially when applied in the form of *concrete* to the foundations of dwelling-houses—a purpose, by-the-by, to which it is unfortunately but too seldom applied. For coating walls exposed to damp, about 2 parts of cement

to 3 parts of sand are commonly employed. Ordinary "compo'," or Roman cement, as it is sometimes called, is used for facing houses, cisterns, walls, etc.

Steam-boiler cement is prepared by mixing litharge (powdered), 2 parts; finest sand and quicklime, of each 1 part. The lime should be allowed to slaken spontaneously. The cement must be kept in a closely-covered vessel. When required for use it is mixed up into a paste with boiled linseed oil, and is employed for stopping cracks in boilers and ovens, for securing steam-joints, etc

Dihl waterproof cement is composed of porcelain clay, or pipeclay, dried at a gentle heat, powdered, and mixed up into a paste with boiled linseed oil, with sometimes the addition of a little oil of turpentine. It may be coloured by adding small quantities of red or yellow ochre, etc. It is sometimes used to cover the roofs of verandahs, and for other useful purposes.

Engineers' cement.—Equal parts of redlead and whitelead, worked up to a proper consistence with boiled linseed oil, forms a composition much used by engineers for securing pipe-joints, etc. It is commonly the practice to smear thin lengths of tow or hemp with the mixture, and to twine this round the thread of the pipe, the second pipe to be united is then screwed tightly on to the first until the junction is complete. It is seldom that a joint thus made needs further attention for many years. It is said that cisterns made of square stones and united with this cement seldom if ever leak or get out of repair.

Fireproof cement.—Mix into a thin paste fine river-sand, 20 parts; litharge (oxide of lead), 2 parts; quicklime, 1 part, with sufficient linseed oil. If applied to walls

it soon becomes exceedingly hard, and forms a very durable coating.

PRINCE RUPERT'S DROPS.

These interesting trifles are formed by allowing melted glass to drop into cold water. The drops, or glass tears, as they are sometimes called, are of a pear shape, broad at one end and tapering to a very thin tail at the other. If a part of the tail be snapped off, the whole flies into fragments with a loud explosion. The tail, however, may be cut away by a glasscutter's wheel, or the thicker end of the drop may be struck with a hammer without sustaining injury. When heated to redness, and afterwards allowed to cool gradually, the remarkable properties referred to do not manifest themselves; indeed the drops do not then differ from ordinary glass. "Prince Rupert's drops" may generally be seen in the shop windows of the scientific glassblowers in the neighbourhood of Hatton Garden.

ETCHING ON GLASS.

Indestructible drawings on glass are made by a cold chemical process, by etching with diluted hydro-fluoric acid, first covering the places not to be eaten away with an acid-resisting material. The fluoric acid dissolves the glass without affecting the appearance of the parts protected. In consequence, the drawing or design appears slightly opaque. The desired effect is then obtained by mechanical means. The elevated parts are ground rough, so that the alternate rough and smooth portions form the picture. The drawings must be etched deep, in order to avoid the deep lines in the mechanical work. It is necessary that all parts which are

to become opaque must be covered with the coating, in order to avoid their destruction by the fluoric acid.

A new process described by Herr Gruene avoids all the difficulties surrounding the present process of etching, and enables the workman to stamp, mark, and ornament glass as if it were paper. The principle applied is as follows: The quality of the fluoric acid used is the same as in the old process, but the drawing is no longer made with a substance absolutely proof against the acid, but with another protecting the glass only to a certain point of time, thus showing in the drawing the elevated marked opaque appearance. For such a covering almost all the lacs, old varnishes, greasy printing dyes, etc., except the solutions of asphaltum, gutta-percha, and caoutchouc, can be used. If applied thin, they yield to the concentrated fluoric acid, even after a few seconds, no matter how firmly dried they may have become. If the substances for covering are used simply for the above-named purposes, they yield only a very feebly-marked design, partly marked and partly blank; but if dusted after application with a finely-pulverized powder of metal, copal, or any other substance capable of rendering longer resistance to the fluoric acid, the opaque drawing is obtained directly. This is the essential point of the invention.

For practical use the following advantages become apparent: 1. As the etching is rapid and not deep, no special protection of the surface by coating with acid-resisting material is necessary. 2. As only slightly-resisting covering substances are necessary, the workman can use not only brushes, gravers, pens, and patterns for drawing purposes, but can also easily make transfers from all typographical, lithographical, copper, zinc, glass, and other prints. In like manner elastic stamps and forms can

readily be used. As one can use, *ad libitum*, thicker or thinner coats, as well as apply coarser or finer powder for dusting, the opaque parts can be produced in any grain desired. In one and the same etching graded designs with proportional shades can also be produced.

The practical execution of this style of etching is carried out as follows: The article to be decorated receives the drawing by hand, stamp, or, as the case may be, by transfer. For the material choose an oily lac mixed with a little paint, so as to show on the glass. This done, dust in the powder. When dry, dip the part with the drawing into the fluoric acid, or put the latter on with a brush, and allow to remain a few seconds, or until the powder begins to come off; then rinse with water. The greasy substance need not be removed, as the fluoric acid absorbs it.

MANUFACTURE OF LEAD SHOT.

After many failures in the manufacture of lead shot, it was discovered that the chief cause of the irregularities in form which the shot exhibited were due to the too sudden cooling of the metal. This was subsequently overcome by constructing shot-towers of considerable height, as, for example, the old square shot-tower near Waterloo Bridge, London, and the more recent structure, the round shot-tower in the same vicinity.

In preparing the metal for shot-making, about 3 lbs. of arsenic are added to each 1000 lbs. of soft lead. When inferior lead is used, about 8 lbs. of arsenic per 1000 lbs. of lead is employed. The arsenic is added gradually to the molten metal, with which it is allowed to

become thoroughly alloyed. The importance of adding arsenic to the lead will be seen when it is stated that if the shots appear lens-shaped, it is owing to the arsenic being in excess; if, on the other hand, they are flattened upon one side, if they are hollowed in the middle, or have a tail, the proportion of arsenic has been insufficient.

Among the many patented processes for shot-making may be selected the following: "Melt a ton of soft lead, and sprinkle round its sides, in an iron pot, about two shovelfuls of wood ashes, taking care to leave the centre clear; then put into the middle about 40 lbs. of arsenic to form a rich alloy with the lead. Cover the pot with an iron lid, and lute the joints quickly with loam or mortar to confine the arsenical vapours, keeping up a moderate fire to maintain the mixture fluid for three or four hours; after which skim carefully, and run the alloy into moulds to form ingots or pigs. The composition thus made is to be put in the proportion of one pig or ingot into 1000 lbs. of melted ordinary lead. When the whole is well combined, take a perforated skimmer and let a few drops of it fall from some height into a tub of water. If they do not appear globular, some more arsenical alloy must be added."

Several tons of the metal are generally melted at a time in large establishments. After a time the surface of the lead becomes coated with a layer of oxide, of a spongy nature, and this is used to cover over the bottom of the cullender, to prevent the lead from running too rapidly through the holes, and thus forming oblong spheroids. The cullenders employed in "granulating" the lead are hollow vessels made of sheet iron about 10 inches in diameter, perforated with holes of uniform size for each

cullender. Cullenders perforated with various-sized holes are employed for the different kinds of shot. These holes vary from $\frac{1}{50}$ to $\frac{1}{80}$ of an inch. The process is conducted with three cullenders at a time, which are kept apart from each other by burning charcoal to keep the metal at the proper temperature. For the smaller shot a fall of 100 feet is required before the shot reaches the water-tub below. The larger shot requires a fall of at least 150 feet.

The workman having put the filter-stuff into the cullender, fills an iron ladle with the molten metal, and pours it slowly into the cullender. Sometimes the three cullenders employed may have holes of different sizes, in which case the shot which falls into the tub will vary in size. These are afterwards separated by means of square sieves perforated with holes corresponding with those in the cullenders. These sieves are placed above one another, by which the larger shots remain in the sieve above, while the other sizes are retained by the sieves below.

The shot has next to be sorted as to form, by which the spheroids which are not truly round, or may be otherwise defective, are separated. For this purpose the shot is placed, a handful at a time, on a board with upright ledges on each side, which is slightly inclined, and gently shaken, by which means the round shot rolls away into a vessel beneath, while those of irregular shape remain on the sides of the tray; these latter are put aside to be remelted.

The shot is finally polished by being placed in a small octagonal cask, turning upon a horizontal axis, which is set in motion by steam-power. Plumbago, or blacklead, is put into the cask with the shot to aid in the process of polishing and rendering the shot smooth.

METAL-SPINNING.

Spinning is a term employed in sheet-metal work to indicate a process of drawing and shaping, which in many of its features resembles the operation of turning in wood etc. A lathe is employed, by which a metal blank and a "chuck" are rapidly revolved, and the shape is imparted to the metal by the pressure of a blunt tool. The metals used in spun-work are sheet zinc, copper, brass, and some of the soft and ductile alloys.

In the manufacture of sheet-metal cornices and other decorative work for buildings, spun-work forms an important feature, being used both in the principal parts and for purposes of ornament. The metal used for this purpose is ordinarily sheet zinc, although occasionally copper and brass are employed. The chucks are turned from gum, apple, cherry, or other tough or close-grained woods, for ordinary qualities, but where a very large number of a pattern is required metal chucks are employed. For large shapes, wood is employed exclusively. In using wood chucks green timber is generally preferred, on account of its greater solidity, absence from seasoning cracks, and from its being more easily turned to shape. When a wood chuck is taken off the spindle for any purpose, with the expectation of using it again, it is preserved during the interval either by immersion in water or by burying in wet shavings or moist earth. The greatest care is necessary in the use of wood chucks, except when very few pieces of a kind are required, to preserve them both from seasoning or shrinking, and from being reduced in size by the careless use of the trimming tool employed upon the metal. For metal chucks

cast iron or cast zinc are employed. The latter possesses advantages over the former in the convenience of casting with the common appliances of the workshop. While cast iron can be obtained only by ordinary foundry processes, necessitating delay, it possesses the compensating advantages of wearing longer, producing smoother and more accurate work, and costing less.

In lamp and other similar work the art of metal-spinning has been developed to a very high degree. By means of compound chucks, or those which are constructed in sections and locked together with a key which provides a means of withdrawing this from finished work, forms are produced from one piece of metal, having alternate ridges and depressions, neck-shaped like bottles, which on casual inspection appear marvellous. In small articles of this nature, brass is very generally employed. Repeated annealing is required during the process, and great skill in the operator is essential.

In large articles equally unexpected results by this manipulation are produced, although differing very much from those just described. In large forms, like those used for the borders of centre-pieces for the ceilings of rooms, and for similar purposes, which are ordinarily produced only by the aid of several seams, the expert spinner, by the use of several chucks with the same blank, first applying one side toward the chuck and then the other, as the forms to be made are either projections or depressions, will produce all the elements of an intricate moulding in one piece. The lid or cover, as of a bucket or water-cooler, together with the rim which fits into the neck and its projecting edge, are made in one piece also. Both of these examples are produced in ordinary sheet zinc.

In the process of zinc-spinning, frequent annealing is necessary. The appliances for this are an open charcoal fire, a gas jet, a flame from gasoline, or an annealing oven constructed upon the same general principle as employed in zinc-stamping. This may be described as a flame-encircled box, which, in its situation and arrangement, in some respects resembles the oven in an ordinary cooking-stove, into which are laid the blanks in piles. The heating process is slow, but a pile of blanks once brought up to the proper temperature retains its heat for a comparatively long time, even when removed from the oven.

Spun-metal work, besides being employed in cornice-work, lamps and lanterns, as above mentioned, enters into the trimmings and decorations of gas-fixtures, lightning-rods, weather-vanes, spire ornaments, and finials. It is used extensively in the manufacture of plated ware, water-coolers, spice-canisters, bird-cages, and many other articles. The use determines the metal employed, the process of manipulation remaining substantially the same in all.

CUTLERY.

The manufacture of cutlery is not only one of the most important, but probably one of the most successful, of our mechanical industries. There are three kinds of steel employed in the manufacture, namely, cast steel, shear steel, and what is called common steel.

Edge-tools, which require to possess tenacity without excessive hardness, are made from shear steel, which is exceedingly tough and pliable. Table-knives, shears, scissors, scythes, etc., are made from this kind of steel, while razors are usually made from cast steel.

In making table-knives, the first operation is termed *forging;* this is generally conducted by two workmen. The blade is first roughly formed and then cut to a certain length, after which it is welded to a rod of iron about ½ inch square in such a way that very little of the iron is visible upon the blade. A certain portion of the iron rod, now welded to the blade, is next taken off to form the shoulder and tang, and in order to make the former of the proper size it is placed in a die, and a "swage" passed over it; the "striker" then gives a few smart blows, by which the shoulder becomes neatly fashioned. The blade is now again heated and finished on the anvil; it is afterwards made red-hot, then plunged into cold water, by which it becomes *hardened,* and is finally *tempered* by gentle heat until it assumes a *blue* colour. It is then ready for the operation of grinding, which is effected by means of emery-wheels kept in motion by steam-power.

Ordinary table-knives are made by cutting the blades out of sheet steel, and the backs, shoulders, and tangs, made of wrought iron, are welded together at a forge. The after operations are the same as those above described. In the United States, table-knives of excellent quality are made almost entirely by machinery, and at prices far below those of Sheffield manufacture. Indeed this town, so long and creditably known for the excellence of its cutlery, has suffered greatly by the influx of American cutlery, much in the same way that many of our arts have suffered—by unreciprocated free-trade.

Fork-making is a separate branch of the cutlery trade, and knife-manufacturers purchase them, ready for fitting into the handles, from the forkmakers. The process of making steel forks may be thus briefly described: Steel

rod, about $\frac{1}{8}$ of an inch square, is employed, the shank and tang of the fork being first forged into shape, after which the fork is cut off, leaving about 1 inch of the square steel at one end; this part is next drawn out flat to the required length of the prongs. The shank and tang are now heated and fashioned to the proper shape by means of a die and swage. The prongs are next formed at a blow by means of a heavy stamp, after which the insides of the prongs are filed; they are then bent to their proper shape, and hardened as before described, being finally tempered by applying gentle heat.

Penknives are commonly forged by one person only. A rod of steel is taken, and the blade of the knife forged out to the proper length, after which this is cut off from the rod, sufficient steel being retained to form the joint. The blade is now held in a pair of tongs and subjected to heat, after which the joint is finished. After another heating, and hammering on the anvil, the blade is finished; but while still hot the "nail-hole," by which the knife is opened, is formed by means of a chisel flat on one side and round on the other. To harden the blades, they are first made red-hot, and then plunged into cold water as far as the shoulder, after which they are placed, *on their backs,* upon an iron plate, and heated until the surface of the steel assumes an orange-brown colour.

Razors are forged from cast-steel rods about $\frac{1}{2}$ inch wide and of a thickness equal to the back of the razor, and the anvil used is somewhat rounded at its sides, by which the edge may be rendered thinner than the other parts of the blade. The tempering of razors, after hardening, is not pushed so far as for penknives, a pale-straw colour being the most suitable tint at which the operation

should be checked by cooling (see *Hardening* and *Tempering*).

Dr. Ure thus describes the interesting art of scissor-making, and the subsequent processes of grinding and polishing articles of cutlery:—

"The forging of scissors is wholly performed by the hammer, and all the sizes are made by a single hand. The anvil of the scissor-maker weighs about $1\frac{1}{2}$ cwt.; it measures, on the face, about 4 by 11 inches. It is provided with two gates or grooves for the reception of various little indented tools termed by the workmen bosses. One of these bosses is employed to give proper figure to the shank of the scissors; another for forming that part which has to make the joint; and a third is made use of for giving a proper figure to the upper side of the blade. There is also another anvil placed on the same block, containing two or three tools called beak-irons, each consisting of an upright stem about 6 inches high, at the top of which a horizontal beak projects. One of these beaks is conical, and is used for extending the bow of the scissors; the other is a segment of a cylinder with the round side upwards, containing a recess for giving a proper shape and smoothness to the inside of the bow.

"The shank of the scissors is first formed by means of one of the bosses above described, leaving as much steel at the end as will form the blade. A hole is then punched about $\frac{1}{4}$ of an inch in width, a little above the shank. The blade is drawn out and finished, and the scissors separated from the rod a little above the hole. It is heated a third time, and the small hole above mentioned is extended upon the beak-irons so as to form the bow.

This finishes the forging of scissors. They are promiscuously made in pairs. They are next annealed for the purpose of filing such parts of them as cannot be ground, and afterwards paired.

"Very large scissors are made partly of iron, the blades being of steel.

"After the forging, the bow and joints, and such shanks as cannot be ground, are filed. The rivet-hole is then bored, through which they are to be screwed or riveted together. This common kind of scissors is only hardened up to the joint. They are tempered down to a purple or blue colour. In this state they are taken to the grinder.

"*Grinding and polishing of cutlery.*—The various processes which come under this denomination are performed by machinery, moving in general by the power of the steam-engine or water-wheel.

"Grinding-wheels or grinding-mills are divided into a number of separate rooms; every room contains six places called troughs; each trough consists of a convenience for running a grindstone and a polisher at the same time, which is generally occupied by a man and a boy.

"The business of the grinder is generally divided into three stages—viz. grinding, glazing, and polishing. The grinding is performed upon stones of various qualities and sizes, depending on the articles to be ground. Those exposing much flat surface, such as saws, fenders, etc., require stones of great diameter; while razors, whose surface is concave, require to be ground upon stones of very small dimensions. Those articles which require a certain temper, which is the case with most cutting instruments, are mostly ground on a wet stone; for which purpose the stone hangs within the iron trough, filled with water to such

a height that its surface may just touch the face of the stone.

"Glazing is a process following that of grinding. It consists in giving that degree of lustre and smoothness to an article which can be effected by means of emery of the various degrees of fineness. The tool on which the glazing is performed is termed a glazer. It consists of a circular piece of wood, formed of a number of pieces in such a manner that its edge or face may always present the endway of the wood. Were it made otherwise, the contraction of the parts would destroy its circular figure. It is fixed upon an iron axis similar to that of the stone. Some glazers are covered on the face with leather, others with metal consisting of an alloy of lead and tin; the latter are termed caps. In others, the wooden surface above is made use of. Some of the leather-faced glazers, such as are used for forks, table-knives, edge-tools, and all the coarser polished articles, are first coated with a solution of glue, and then covered with emery. The surfaces of the others are prepared for use by first turning the face very true, then filling it with small notches by means of a sharp-ended hammer, and lastly filling up the interstices with a compound of tallow and emery.

"The pulley of the glazer is so much less than that of the stone that its velocity is more than double, having in general a surface speed of 1500 feet in a second.

"The process of polishing consists in giving the most perfect polish to the different articles. Nothing is subjected to this operation but what is made of cast steel, and has been previously hardened and tempered.

"The polisher consists of a circular piece of wood covered with buff leather, the surface of which is covered from time to time, while in use, with crocus. The

polisher requires to run at a speed much short of that of the stone or the glazer. Whatever may be its diameter, the surface must not move at a rate exceeding 70 or 80 feet in a second."

CRAYONS.

These "coloured chalks," as they are sometimes called, are prepared from pipeclay, or China clay, with the addition of certain mineral or metallic pigments. In Paris crayons are prepared from the following mixture: Shellac, 6 parts; spirit of wine, 4 parts; turpentine, 2 parts; colouring powder, as vermilion, Prussian blue, orpiment, etc., 12 parts; blue clay, 12 parts. The clay is well mixed up with water, and after allowing it to stand for a few seconds, the liquor holding the finest particles in suspension is poured off, and this is allowed to settle. The clear water is afterwards poured off, and the pasty mass carefully dried. The shellac, after being dissolved in the spirit of wine, is to be incorporated with the dried clay, colouring powder, and the turpentine, until the whole assumes the consistence of putty. The careful mixing of the ingredients is of great importance, in order to ensure uniformity. When the mixture is complete, the mass is pressed into suitable moulds to give the crayons the proper form, after which they are carefully and gradually dried in a stove or oven.

Bright red crayons may be made by reducing red hematite (native peroxide of iron) to a fine powder, and separating the finer particles by washing, as above. The resulting red mass is then to be made into a thick paste with gum-arabic and a little curd or Castile soap, and is afterwards moulded by forcing it through a syringe, and then dried

into crayons. Care must be taken not to employ an excess of gum, otherwise the crayons will be too hard to produce the required tracings on paper.

Crayons of very good quality may be made by the amateur by simply working up into a paste, with a little pale ale, ordinary pipeclay, with the addition of any metallic or earthy colouring matter, as yellow ochre, red ochre, orpiment, lemon chrome, orange chrome, vermilion, sap green, powdered Prussian blue, blue verditer, etc. In order to make crayons of the various shades and tints of colour required for chalk-drawing, it is necessary to mix the colouring matters in due proportions with the pipeclay; thus the varied shades of green must be prepared by mixing blue and yellow, the addition of vandyke or other browns being employed to produce the darker tints of green. When it is borne in mind that crayon colours cannot be mixed, like water or oil colours, at the time of using them, it is necessary to have at least three or four shades of each colour always at hand, so that the artist may produce any desired effect.

Black crayons may be prepared from lampblack, ivory black, or blacklead. Good charcoal, cut into the suitable form, is frequently used as a crayon in this class of drawing. If any of these ingredients, in fine powder, are mixed with melted wax, they form excellent black crayons.

Brown crayons may be made from burned or raw sienna, burned or raw amber, etc.; carmine and black may be added to give certain peculiar tints occasionally required.

For various tints of red, carmine and carminated lake may be mixed with pipeclay, or prepared chalk, with or without the addition of a little gum.

King's yellow, Naples yellow, yellow ochre, etc., are also used in making yellow crayons.

MANUFACTURE OF TIN-PLATE.

Sheet iron, previously prepared, is dipped into a bath of melted tin, by which it becomes coated with that metal, forming the so-called "sheet tin," or tin-plate, of commerce. The process of manufacture is conducted somewhat as follows: The sheet iron is first cut into certain sizes; it is then cleansed from the "scale," or oxide, which occurs on its surface in the process of manufacture, after which the plates, as they are called, are dipped for a few minutes in a bath composed of dilute hydrochloric acid (muriatic acid); they are next drained from the acid and afterwards made red-hot, by which process the *scale* chips off, leaving the iron tolerably clean. The plates are afterwards passed through chilled rollers, and next plunged into a dilute acid-bath made by fermenting bran-water. They are next put into a leaden trough containing dilute oil of vitriol. This "pickle," as it is termed, removes any oxide that may be upon the surface. After about an hour the plates are removed, rinsed in clean water, and well scoured with sand and water, and are then placed in clean water until required for the subsequent operation of tinning, etc.

The *tinning* process is conducted as follows: A series of cast-iron pots are arranged over a fire flue. The first pot contains the melted tin; the second is the wash-pot; the third the grease-pot; the fourth is the pan, with a grated bottom; and the fifth is the list-pot. The plates are first dried in bran, and are then, one by one, dipped in melted tallow, in which they are allowed to remain for a short time; they are next removed and dipped into the tin-bath composed of a mixture of block and grain tin covered with a

layer of tallow to prevent oxidation of the metal. The plates are allowed to remain in the molten tin for an hour or more, after which they are removed, and placed on the grating to allow the superfluous tin to run off. The next operation, called "washing," consists in dipping the plates in a pot containing melted *grain* tin, which assists in removing the superfluous coarse tin imparted by the first process. The plates are taken out of the grain-tin pot, one by one, by means of a pair of tongs, held in the left hand, and the workman scrubs each plate with a hempen brush, held in the right hand. The plate is next dipped for a moment once more in the wash-pot, and afterwards in the grease-pot. Great care is necessary to keep the grease at the proper temperature, by which the brightness of the plates, as they come from the metal-pot, is maintained. The plates are finally cleansed from the tallow by being rubbed with bran; they are afterwards packed in boxes, each box containing 225 plates.

MOIRÉE METALLIQUE.

A beautiful crystalline appearance is imparted to tin plates (see p. 42) by the action of dilute acids. Under the title of *moirée metallique* the art of ornamenting tin at one time attained great popularity, and indeed at the present day it is much practised both in this country and on the Continent. If we remember rightly, the late Sir Isambard Brunel, the gifted designer of the Thames Tunnel, patented a process for ornamenting tin by means of acid solutions many years ago.

To impart to sheet tin the crystalline effects referred to, the metal is first slightly heated, after which its surface

is gently rubbed over with a sponge dipped in an acid solution made by mixing nitric acid, 4 parts; distilled water, 2 parts; sal-ammoniac, or common salt, 1 part. Dissolve the salt in the water before adding the acid. In a very few moments after the sponge has been applied the crystalline appearance will be developed, when the plates should be at once plunged into clean water, and the surface of the metal may be gently brushed over with a piece of cotton wool while still under the water. The crystalline effect may be modified by sprinkling water over the surface of the plate before immersing it in water.

A very pleasing effect is produced upon a piece of sheet tin by gently heating its centre by holding it over the flame of a candle for an instant—that is, until it has become moderately warm—and then passing the sponge dipped in the acid solution over the part heated.

In order to add greater beauty to articles made from sheet tin, ornamented as above described, various coloured varnishes are employed; and the spangled effects of the crystalline surface, as seen through the varnish, is both pleasing and remarkable.

BALLOONS.

It is now nearly one hundred years—namely, in the year 1784—since Signor Lunardi made his first balloon ascent from the Artillery Grounds in Moorfields. In the year following Messrs. Blanchard and Jeffries crossed the Channel from Dover to Calais in a balloon. From this period balloon ascents, as a source of attraction to public gardens, became more and more frequent. The elder Green, whose very

numerous ascents from the old Vauxhall Gardens and elsewhere may still be remembered by many, was followed by his son, Henry Green, who was scarcely less famous in his day for the number of times he floated above the surface of the earth to "please a gaping crowd" as some ill-natured people will say. Next came Lieutenant Gale, Adams, Mrs. Graham, and the renowned Henry Coxwell, whose name has been far more scientifically associated with aeronautics, we believe, than that of any man living. Indeed, his vast experience and practical knowledge of the subject has enabled him to render great services to the British and other Governments in connection with the construction of balloons for war purposes. It will be within the recollection of most persons that this eminent aeronaut some years ago, in company with Mr. Glaisher of the Royal Observatory, ascended to an altitude of 6¼ miles; when, owing to the highly rarefied condition of the atmosphere, Mr. Glaisher became insensible, while Mr. Coxwell himself became so far powerless that he was compelled to seize the valve-rope between his teeth to enable the gas to escape so that the voyagers might descend.

With a desire to render the ordinary balloon safer, the author, in 1874, took out a patent for a balloon *constructed in compartments*, so that in the event of one or more compartments becoming injured, from gun-shot or otherwise, the remaining chambers, even to the last of them, would retain sufficient gas to keep the balloon afloat. Being anxious to obtain a practical opinion as to the utility of the new balloon, the author submitted a model of it to Mr. Glaisher, who expressed himself highly pleased with the design, and said that he considered it "a hundred times safer than the ordinary balloon." After fruitless attempts

to induce the "constituted authorities" of the Horse Guards and others to look into the matter, the invention, like many others, was dropped.

Ordinary air-balloons are made of very strong thin silk, specially manufactured for the purpose, and coated with an elastic varnish of drying linseed oil or a solution of india-rubber. The balloon is protected by a netting of strong silk or flaxen cord. The car is made of wicker-work, which, owing to its extreme lightness, is admirably suited to the purpose.

Fire-balloons, as they are called, are made of tissue paper cut into gores, and pasted or gummed together. A ring of thin wire, crossed by two other wires, is attached to an opening at the bottom, and a piece of sponge is fastened to the centre of this, which, being saturated with spirit of wine or wood spirit, and ignited, soon fills the balloon (which should be held erect during inflation) with heated air. Hot air being lighter than the atmosphere, the balloon soon begins to rise—even before it is fully inflated, and so long as the air retains this degree of rarefaction the balloon will continue to float. Montgolfier constructed his first balloon on this principle, and it is not many years since a large balloon, inflated by burned shavings and straw, ascended from Cremorne Gardens.

BREAD-MAKING.

When we came to the letter B in the early days of our caligraphy, with what reverence we must have written "Bread is the staff of life" in the hungry hours of school-time!

The best bread is made from pure wheaten flour, made

into a paste, or dough, with water, to which is added a little common salt and yeast. In the preparation of his dough the baker takes a portion of the water required for a "batch," and adds boiling water to it until it is tepid. To this he adds the salt and yeast, and a portion of the flour, the whole forming a thin dough. This is set aside for a short time in the kneading-trough, when it gradually begins to ferment and swell. After a while the mass assumes a spongy form, swelling up considerably; it then bursts and subsides alternately, and when the baker considers that the process of fermentation has proceeded far enough, and before the dough becomes *sour*, he adds the remaining quantity of flour, salt and water, to complete the batch, and then proceeds to knead the whole until it is sufficiently tough to bear the pressure of the hand without sticking to it. The dough is then set aside for several hours, and fermentation continues. After a while the dough is again kneaded, then cut into pieces, which are weighed, and these are next formed into loaves. These loaves, after a time, swell to nearly double their size, when they are at once placed in the oven and baked. Soon after being put in the oven the loaves attain a still greater size, from the expansion of the carbonic acid gas which is generated during the fermentation; but eventually the outer surface becomes hardened, and the bread then retains its form and size.

White bread is made from the best wheaten flour; **ordinary wheaten bread** from flour containing a little of the finest bran; **seconds bread** contains a larger proportion of bran, while ordinary **household bread** is made from flour from which the bran has not been separated. This latter is unquestionably the most wholesome, as also the most

nutritious kind of bread which the noble grain is capable of yielding, and it is much to be deplored that it is so little used. Indeed it has been for many years the opinion of men of science that dyspepsia has been greatly promoted by the continual use of bread made from flour deprived of its bran—the most nutritious part of the grain. When fashion changes, and sallow complexions cease to be admired, probably whole-meal bread—the *real* "staff of life"—may take the place of the stuff of custom which at present usurps the place of bread.

Considering the vast importance which attaches to the principal food of the community, it seems strange that those in authority should so persistently "wink at" the wholesale adulteration and sophistication to which our daily bread is subject, at the hands of unscrupulous and selfish tradesmen and millers.

When it is stated that amongst the favourite adulterants employed in the "manufacture" of bread are bone-dust, chalk, and plaster of Paris, besides potatoes, beans, and rice, it will be understood that the baker, and not the consumer, is most likely to fatten on the product. The employment of alum, as a means of producing artificial whiteness in damaged or inferior flour, has often been the subject of controversy; but unfortunately those whose duty it is to guard the public from the pernicious trickeries of trade appear loth to interfere with the "freedom" even of the most dishonest.

Mr. Cooley, who had considerable experience in the analysis of bread, says: "In the manufacture of white bread from damaged or inferior flour, a large quantity of alum is employed by the fraudulent baker; but with the best flour no alum is required. The utmost beauty, sponginess, and

sweetness may be given to bread without the addition of *one particle of alum*, provided the best materials alone enter into its composition. As such materials are seldom employed by the bakers, the usual practice is to introduce 4 or 5 ounces of alum to every sack of flour, or about 1 ounce to each bushel; and very frequently fully *double this quantity of alum* is employed. But even this *enormous quantity* is often *not* the *whole* of the alum present in common bread; for the miller, in order to *cheat* the *baker*, puts in the 'doctor' in the shape of 4 to 6 ounces of alum to the sack, whilst the baker, unconscious of this victimization, subsequently uses a double dose of alum in order to *cheat* his *customers*."

There can be no doubt whatever that if any addition is necessary to improve the condition of inferior flour, the bicarbonate of soda would prove the most harmless, if not the most effective, ingredient. Magnesia has been recommended for this purpose, but we are of opinion that the continued consumption of bread laden with magnesia would soon prove highly injurious—more especially to young children, whose daily consumption of bread is often considerable.

French bread is made from fine flour, and it is commonly the practice, in making the better qualities of fancy bread, as rolls and small loaves, for instance, to make the dough with milk and water, with sometimes the addition of a little butter. The following directions have been given for baking this class of bread: "When the rolls, or small fancy loaves, have lain in a quick oven about a quarter of an hour, turn them on the other side for about a quarter of an hour longer. Then take them out and chip them with a knife, which will make them look spongy, and of a fine

yellow; whereas rasping takes off this fine colour, and renders their look less inviting."

A very wholesome household bread was suggested by the Rev. Mr. Haggett. It is made as follows: Remove the flake-bran from flour 14 lbs.; boil the bran in 1 gallon of water until reduced to 7 pints; strain, cool, and knead in the flour, adding salt and yeast as for other bread.

Some years ago there was a strong desire to introduce "unfermented bread" as a substitute for the ordinary bread made with *yeast*, or with *leaven*—that is, thin dough which has been allowed to undergo fermentation, or semi-putrefaction. One of the best formulæ for the preparation of unfermented bread is that made from Jones' patent flour,* as follows: 'Take kiln-dried flour, 1 cwt.; tartaric acid, 10½ ounces; mix thoroughly. After two or three days add bicarbonate of soda, 12 ounces; lump sugar, ½ lb.; common salt, 1½ lb.; mix, and pass the compound through the 'dressing-machine.' It is necessary that all the ingredients should be *perfectly dry*, and thoroughly well mixed. By simply mixing this flour with *cold* water and at once baking it, it produces a light, porous bread."

PAPIER-MACHÉ.

Paper reduced to pulp by boiling in water, and the pulp afterwards strained and moulded into any desired form, constitutes what is termed *papier-maché*. Any old paper may be used for this purpose, and the articles made from the pulp may be japanned, or painted, and possess great durability and toughness with exceeding lightness. Sulphate of iron and quicklime, as also albumen, or white of egg, are sometimes added to the pulp to render the articles

* Called "Self-raising flour."

made from it waterproof; and phosphate of soda, borax, and other substances are sometimes added to render the articles non-combustible. Papier-maché tea-trays, which have long been in vogue, are made by uniting layers of brown paper by means of paste or thin glue, and afterwards submitting them to powerful pressure. When dry, such articles become exceedingly hard. A final coating of Japan varnish, with a certain amount of ornamentation, completes the manufacture. Recently, washing-basins, jugs, and other utensils have been made from paper pulp, and in the United States they are now manufacturing innumerable articles from this material.

GALVANIZED IRON.

The so-called "galvanized" iron is in reality sheet iron coated with zinc. The process is conducted on a very large scale by Messrs. Morewood & Co. of Birmingham, and other large firms. The sheet iron is first placed in a "pickle" of hydrochloric acid diluted with water, or in a solution of sulphuric acid (oil of vitriol). After being in the pickle-bath about half an hour, the black *scale*, as it is termed, with which sheet iron is covered, becomes loosened, and can readily be removed by scouring with sand and water, applied with hard brushes. After the plates, or iron utensils, are well pickled and scoured, they are held by the workmen by suitable tongs, and plunged into a bath of molten zinc, which, to prevent oxidation of the surface, is covered with sal-ammoniac in fine powder. When the sheets, etc., have been immersed in the melted zinc sufficiently long, they are carefully withdrawn, knocked against the side of the bath to shake off superfluous metal, and are then set aside to cool. Since the zinc, in this

operation, alloys itself with the iron to a considerable extent, the sheets, if not carefully treated, are apt to become brittle, and consequently difficult to handle without breaking.

During the process of cleaning, or preparing the articles for the zinc-bath, great care is observed to examine every part of the surface, since the smallest particle of scale or other impurity on the surface of the iron would not "take" or become coated with the zinc; and should these necessary precautions be neglected, each defective spot—especially in galvanized sheet iron which has to be exposed to the vicissitudes of weather—would ultimately lead to the destruction of that part of the object in which the flaw or imperfection existed. Indeed when a surface of iron is coated with zinc, and subjected to alternations of rain and drought, electro-chemical action becomes so vigorous at each defective part that in a very short time the more oxidizable metal (iron) becomes eaten away, and a hole is the result.

It has been the practice of late years to manufacture utensils, such as cisterns, buckets, etc., of good wrought iron; and when coated with zinc, they form exceedingly useful and cheap vessels for holding or conveying water, and are largely used both at home and abroad.

Galvanized-iron chains, bolts, tubes, corrugated sheet iron, gutter-pipes, and many other articles are prepared by the zincing process.

GOLD-BEATING.

The art of reducing gold to an excessive thinness by hammering, appears to have been known to the Romans,

for, according to Pliny, the ceilings and walls of their dwellings were ornamented with leaf-gold.

The extreme malleability of pure gold enables it to be reduced, by hammering, to a degree of thinness equal to 651,590 times greater in surface than its original size when cast. There are four distinct operations in the art of gold-beating—namely, casting the ingots, hammering, rolling, and beating.

The gold is first melted in a crucible, with a little borax as a flux. When thoroughly melted it is poured into an iron mould previously made warm and greased inside. When the ingot has become solid, it is removed from the mould, and placed on a clear fire until moderately red-hot, by which any grease on the surface becomes burned off, and the metal becomes *annealed*, as it is termed. The gold ingot weighs about 2 ounces, and is about $\frac{3}{4}$ of an inch in width. When the ingot is cold it is passed between a pair of bright steel rollers, by which it becomes extended in length very considerably. The ribbon of gold thus produced is afterwards annealed several times, and rolled out after each annealing until of such a thinness that a square inch of it weighs $6\frac{1}{2}$ grains.

Before *beating* the gold the workman cuts the ribbon with shears into squares of about 1 inch each, taking care to have them as nearly uniform in size and weight as possible. These squares of gold are then piled up, one above another, with a layer of fine calfskin vellum placed between each strip, and about twenty extra pieces of vellum are placed above and below the pile. The pieces of vellum are about 4 inches square, and in the centre of these the pile of gold is placed. To prevent the pieces of gold from shifting their position, a band of strong parchment is

fastened round the packet, open at each end. A short-handled hammer weighing about 15 or 16 lbs., and having a round but slightly convex face, is employed, and with this the workman strikes the packet with considerable force, by which the gold becomes extended in width at all points.

Gold-beating is conducted on a strong bench, on which is a solid block of marble about 9 inches square, enclosed in a framework, except in the front, at which a leather apron is fixed for receiving any fragments of gold which may fall from the packet during the operation of beating. The workman is very careful to ply his hammer with great precision, so as to strike the packet uniformly in the centre, and he frequently turns the packet over, so as to strike both sides equally; and this movement is done so dexterously that the packet becomes reversed between every two strokes of the hammer. Occasionally the goldbeater loosens the band which confines the packet, and examines the gold so as to shift those pieces which may have been less affected by the hammer. When the leaves, after being thus beaten, have extended to near the margin of the vellum, they are removed from the packet, and each is cut into four equal squares with a knife. By this they become reduced to about the original size, though of course much thinner. The plates of gold are again made into a packet as before, and this time they are separated by a layer of prepared ox-gut instead of vellum.

The second beating is performed with a smaller hammer than that employed in the first operation; its weight is about 10 lbs. The beating is now continued until the gold-leaf extends to the size of the skins; but during the operation the packet has to be frequently opened to loosen

the gold from the skins. The leaves are now spread on a "cushion," and once more subdivided into four square pieces each, by means of two pieces of cane, each cut to a very sharp edge, and fastened together in the form of a cross, which is pressed down upon each leaf, whereby it becomes divided into four equal parts. These are again made up into a packet and finally beaten out to the size of ordinary gold-leaf—that is, about 3 to 3½ inches square.

The leaves of gold are next made up into small books, each leaf of paper being rubbed over with red chalk to prevent the delicate gold-leaf from becoming attached to it; but before being placed in the books, the gold-leaves are first cut to a uniform size by means of a frame made of cane, with a keen-cutting edge. When this frame is pressed on the leaf it cuts it readily to the required size. A book usually contains twenty-five gold-leaves.

GILDING WITH GOLD-LEAF.

This is an important industry, and the purposes to which it is applied are so numerous that many distinct arts are involved in its application.

Picture-frames, and other ornamental work of a like character, are generally gilt by the process which is termed **oil gilding**—that is, the surface to be covered with gold-leaf is first brushed over with a preparation of drying linseed oil, whitelead, and a little oil of turpentine. A second coating is then given, with a mixture of calcined redlead, unboiled linseed oil, and a little essence of turpentine. Three or four coats of this are applied to the ornamental and other parts which have to be well gilt. *Gold colour*, as it is called, is next applied. This is the dregs of the

colours ground in oil which remains in the vessel in which painters clean their brushes; it is of a sticky consistence, and after being well worked up in a pestle and mortar, or on a slab with a muller, and passed through muslin, it forms a good ground for gold-leaf.

Before the leaf is applied, the gilder ascertains, by touching the prepared surface with the back of his hand, whether it is dry enough to take the leaf-gold readily. The leaf is first spread on the cushion, then cut into pieces, adroitly, with the palette-knife, and pressed into its place with a tuft of cotton, or into the deeper places with a camel-hair brush. The gold is smoothed with a wide brush of camel's hair, after which it is left to dry. The gilding is next coated with a layer of spirit varnish.

Burnished gilding is practised as follows: The surface to be gilt is first coated with several layers of whitening and size, after which a coating of gold size is applied; the gold-leaf is then laid on, and it is afterwards burnished down with an agate burnisher or a dog's tooth.

Leaf-gilding on paper is done by first coating it with gum-water or fine size, and when this is nearly, but not quite dry, the leaf is laid on, and is afterwards burnished.

The gilt lettering on bound books is simply done by laying the gold-leaf on the surface, and pressing it down with hot brass stamps or letters. The edges of the leaves of books are gilt by brushing the surface over, while in the press, with a solution of gelatine in spirit of wine, and laying on the leaf when the gelatine becomes "tacky."

OR MOULU.

The beautiful surface noticeable on French clocks and other ornamental work is produced by the process called *or moulu.* The article is first gilt, and afterwards scratch-brushed with a thin paste composed of saltpetre and alum, to which is added a little hematite, or red oxide of iron. These ingredients are reduced to a fine powder, and worked up into a paste with a solution of saffron or annatto, or other colouring matter according to the tint required, whether red or yellow. When the gilding is strong, the article is heated until the coating of the above mixture curls over by being touched with a wet finger. But when the gilding is only a slight film of gold, the mixture is merely allowed to remain upon the article for a few minutes. In both cases the article is quickly washed with warm water containing in suspension a certain quantity of the materials referred to. The article is next dried without washing. Such parts as may have acquired too deep a colour are afterwards struck with a brush made with long bristles. By a series of vertical strokes with the brush the uniformity of surface is produced.

If the first operation has not been successful, the colouring is removed by dipping the article in dilute sulphuric acid, and after well rinsing, the operation is repeated until the desired effect is obtained.

Red or moulu is produced by employing a mixture composed of alum and nitre, of each 30 parts; sulphate of zinc, 8 parts; common salt, 3 parts; red ochre, 28 parts; and sulphate of iron, 1 part. To this may be added a small quantity of annatto, madder, or other colouring matter, ground in water.

Yellow or moulu is produced by the following: Red ochre, 17; potash alum, 50; sulphate of zinc, 10; common salt, 3; and saltpetre, 20 parts, made up into a paste as before.

The **dead or moulu** for clocks is composed of saltpetre, 37; alum, 42; common salt, 12; powdered glass and sulphate of lime, 4; and water, 5 parts. The whole of these substances are to be well ground and mixed with the water.

Gilders' wax, for producing a rich colour upon gilt-work, is made of oil and yellow wax, of each 25 parts; acetate of copper, 13 parts; and red ochre, 37 parts. The oil and wax are to be united by melting, and the other substances, after being well pulverized, added gradually.

MERCURIAL GILDING.

Unlike electro-gilding, which is essentially a chemical operation, the process of mercury-gilding, or "wash-gilding," as it was formerly called, is chiefly mechanical in its manipulations. An amalgam of quicksilver and gold is first formed, and when this is applied to a surface of "gilding metal" (an alloy of copper), it becomes readily attached, and the mercury is afterwards expelled by heat, leaving a layer of gold only on the surface. The remarkable power which quicksilver possesses of dissolving gold and some other metals is thus taken advantage of in the interesting process we are about to describe.

In forming the *amalgam,* a certain weight of standard gold is taken, and this is placed in a crucible; when the gold has become red-hot the proper proportion of mercury is poured in. The usual proportions are about 8 parts of mercury to 1 part of gold. This mixture is carefully

stirred with an iron rod until all the gold is dissolved, when it is poured into a shallow vessel containing water; after well washing the amalgam, the workman squeezes out any loose mercury that may be present, and the amalgam is then squeezed in a chamois-leather bag, through the pores of which the unalloyed mercury oozes. The resulting amalgam contains about 57 grains of gold and 33 grains of mercury in each 100 grains. The mercury which is squeezed through the leather bag contains a good deal of gold, and this is preserved for future use.

To apply the amalgam, a solution is first made by dissolving mercury in nitric acid, which is afterwards diluted with water. The article to be gilt is first "pickled" in a very weak solution of sulphuric acid, and then rinsed in clean water, after which it is brushed with a hard brush. It is then well dried in boxwood sawdust. A gilder's scratch-brush is then dipped in the mercurial solution and passed over a lump of amalgam, after which it is applied to the article to be gilt. This process is repeated as often as necessary. The article is then well washed with water and dried, after which it is placed in a charcoal stove and heated until all the mercury (which is volatile) is expelled. If necessary, an extra coating, or even several, is applied.

Roseleur thus describes the process of mercury-gilding as carried on in France:—

"The amalgam is crystalline, and a certain crackling sound is heard when we crush the crystals between the fingers. A certain stock of amalgam is generally prepared in advance, and it is divided into small balls of nearly equal size, the value of which is ascertained from their number, and from the total weight of gold

employed. Thus, if ten small balls contain altogether 5 grammes of gold, each ball will hold 0·5 gramme of precious metal. These balls are kept in water, but they should not remain too long without being used, because the phenomenon of *liquation* takes place, and the different parts do not present the same composition.

"When using the amalgam, it is spread with the finger upon a flat, hard stone, called the *gilding-stone*, and having dipped a scratch-brush of stout brass wire into a solution of nitrate of binoxide of mercury until it becomes completely white, it is then passed upon the amalgam, a portion of which is carried away. The object, previously well cleansed, is scratch-brushed in every direction, and the tool is often dipped into the mercurial solution in order to facilitate the regular and even spreading of the amalgam.

"This operation requires great care for giving a uniform coat upon the hollow and raised parts.

"When the back part of a piece does not require gilding, the flat outline, and also the back edge, should be gilt, in order that the naked copper shall cause no injury in the subsequent operations.

"When the article is uniformly covered with the amalgam, it is heated upon a charcoal fire without draught, and which rests upon a cast-iron plate. The entire attention of the operator is now required for watching the process. With his left hand covered with a thick glove of buckskin, he turns the piece in every direction upon the fire, and, as the mercury disappears, with his right hand he strikes the article in every direction with a brush, the handle and the bristles of which are long, in order to equalize the gilding, and to push the remaining amalgam upon those parts which appear less charged with it.

"When the whole of the mercury has become volatilized, the gilding has a dull greenish-yellow colour, resembling that of boxwood, and the operator then examines whether the coat of gold is continuous. Should a few bare places appear, a fresh quantity of amalgam is added, and the whole heated again.

"The next operation is scratch-brushing, which furnishes a pale-green colour, and also requires another heating for arriving at the desired shade. The reheating should be sufficient for expelling any remaining mercury, and producing a fine orange-yellow colour.

"We may now proceed to one or two distinct operations, according as we desire a bright or a dead lustre. In the first case, we submit the object, with the aid of heat, to the or-moulu process" (p. 57). "In the second, the object is firmly fixed to an iron rod, with wire of the same metal, and smeared with a hot paste for dead gilding, composed of saltpetre, common salt, and alum. The whole is heated upon a brisk charcoal fire, without draught, and moved about until the mixture becomes dry and begins to fuse, when the article is immediately plunged into a barrel or cask half filled with water. The covering of salts is immediately dissolved, and the dead lustre appears in all its beauty. This operation, without being very difficult, requires a certain amount of practice, and a skilful workman is sought for.

"The gilding must be strong to stand the dead lustre process, especially (as is often the case) when the first trial is not successful.

"An object may possess the right kind of dead lustre and still be covered with red lines left by the iron wire. These disappear by plunging the object into a not too

diluted solution of nitric acid. Pure hydrochloric acid is preferable.

"The gilders with mercury do not employ pure gold; that which they use is previously alloyed with a certain proportion of copper and silver [standard gold]. With the latter metal the gilding is green."

Red gilding is either obtained with a dark or moulu or with the formula on p. 57.

LIGHTNING-CONDUCTORS.

The purpose of the *paratonnerre,* or lightning-conductor, is to protect very high buildings from the effects of lightning, by conducting the electric fluid to the moist earth beneath, where it will do no harm. A paratonnerre is a pointed metallic rod, the length of which varies with the height of the building to which it is applied. It is erected vertically over the object it is intended to protect, as a steeple, chimney-stack, etc. From its base an unbroken series of metallic bars, or rods soldered or welded together end to end, are continued to the ground, where they are buried in moist soil. The main parts of a well-constructed lightning-conductor are the long conducting rod referred to, which is surmounted by the conductor proper, which is sometimes formed of a conical, tapering rod of copper, the apex of which is made of platinum united by means of silver solder. For the greater security of very high chimneys it is not unusual to employ three or even four lightning-conductors, each of which terminates at its apex in a fork made of copper rod. Sometimes the extreme point of the conductor is strongly gilt by electro-deposition, in order to protect the top of the copper rod from oxidation. This is a very

prudent precaution, inasmuch as corroded copper is a very indifferent conductor of electricity.

To make a lightning-conductor on a small scale, a length of stout copper wire will answer the purpose very well. This should be fastened to the building it is intended to protect by means of ordinary iron holdfasts; the wire should be allowed to project at least 2 feet above the building, and the lower end should be sunk at least 4 feet in the soil.

BOOKBINDING.

The process of binding books may be thus simply described: The bookbinder receives the sheets which compose a book directly from the printer, and after having folded them in the order of the *signatures,* or letters at the bottom of the page, he first rolls, or beats them with a hammer, on a stone, to make them lie close and smooth. They are next put into a press and sewed with *bands* or strips of leather fastened at certain distances, which, being all glued together very firmly, form the *back* of the book, to which the pasteboards are attached by means of the bands, so as to form the sides. In this process of fixing on the sides much nicety is required in rounding the back, and keeping the whole firmly fixed in the press. The book is next put into the cutting-press between two boards, one lying even with the press for the knife to run upon, the other above for the knife to run against, and thus the leaves and boards are cut to form an even edge.

The next operation is the sprinkling, marbling, or gilding of the edges; after which the covers of leather, or cloth, having been first moistened, are cut to the size of the

book, smeared with paste, and then stretched successively over the back and the two sides, after having taken off the four angles, and indented and platted the cover at the head band. When thus far finished, the book is covered and bound between two bands, and set aside to dry. It is afterwards washed with paste-and-water, and then sprinkled with a brush, unless it is to be marbled, which is done by making spots with vitriol. The book is then glazed with the white of egg, and lastly polished with a hot iron. The letters and ornaments are made with gilding tools, or brass cylinders, rolled along by a handle: to apply the gold, the leather is glazed with a liquor made of the white of eggs diluted with water, and when nearly dry the gold is laid on. Such is the process when a book is *full bound;* but books are sometimes only sewed, and have a paper cover. Sometimes the boards are covered with paper or cloth only, when they are said to be *in boards;* some books have a leather covering on the back, extending a small way over each side, when they are said to be *half bound.*

Of late years great taste has been exhibited in *cloth bindings*, by weaving cotton cloth in a special way for this purpose, and subsequently stamping it by means of rollers, so as to resemble the texture of leather, or any fancy pattern. *Indiarubber binding* has also been introduced, to increase the flexibility of the backs of books.

MANUFACTURE OF POTTERY AND PORCELAIN.

According to some authorities it was in the seventeenth century that the first small works were established in

Burslem, Staffordshire, for making earthenware of a coarse description, covered with a common lead glaze; and from that period the manufacture of pottery-ware became gradually extended in this county, now so famous for the magnitude of its operations. "It is to the late Josiah Wedgewood," says Ure, "that this country and the world at large are mainly indebted for the great modern advancement of the *ceramic* art. It appears that the French first gave the title *ceramique* to the art of pottery, the word being derived from two Greek words signifying *burned clay*."

The clay from which the best Staffordshire pottery-ware is made is obtained from Dorsetshire and Devonshire; it is of a very infusible nature, and becomes exceedingly white when burned. The operation of cleansing the clay from objectionable matter, such as stones, after its removal from the pits, is conducted with much care. When required for use the clay is first cut into pieces, and afterwards kneaded into a pasty mass by steam-power. It is next placed in an iron cylinder, in which is a revolving shaft furnished with a series of blades, the effect of which is to cut the clay into very small pieces. In this state the clay is conveyed to vats, where it is worked up with water into a thin pap of a creamy consistence. The coarser particles, stones, etc., are allowed to subside, and the finer substance is then passed through a series of fine sieves made respectively of wire, lawn, and silk, and the resulting mass is then diluted with water to a certain standard density.

In order to give the clay thus prepared the proper qualities to resist contraction and cracking by the heat of the kiln in which it is baked, ground flints, reduced to a fine powder, are employed. This flint-powder is made by first

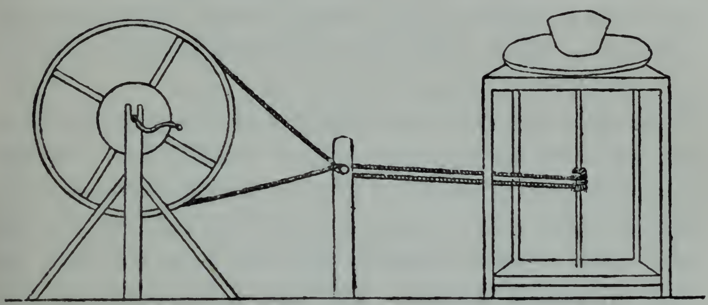
washing the flints obtained from chalk pits, and then calcining or roasting them, after which they are thrown, while still hot, into cold water. The effect of the roasting deprives the flints of their transparent character, and renders them brittle and more readily pulverizable. The finest particles of the ground flint, when carefully washed to free them from the coarser particles, form a pappy mass on subsiding in water, which is afterwards diluted with water to a given standard, and the standard clay and flint liquors are afterwards mixed together in certain proportions, according to the condition of the clay employed. The mixture is afterwards heated to expel a certain amount of its water, when the mass assumes the form of dough. This is afterwards cut into square blocks, which are piled in heaps and stored in a damp cellar for several months. During this period the "dough" undergoes considerable change, almost resembling fermentation in its character, and the "ware" made from it is of a finer quality than that produced from recently-made dough.

When required for use the dough is taken by the workman in both hands, and is then torn asunder, and afterwards the two pieces are slapped together with some force, the separate fragments being united in a different direction from that in which they were at first combined. This operation is repeated several times, and the lump is then dashed on a board and worked up for a considerable time until a perfectly homogeneous mass is formed.

In making articles from the clay prepared as above the first operation is called *throwing*. This is performed on a machine called the potter's lathe, a simple form of which is given below. The flywheel is worked by a handle which sets in motion the upright spindle furnished

with a grooved pulley. The spindle being connected to the round table causes it to revolve horizontally. The speed at which the table moves is regulated by placing the driving cord on the larger or smaller grooves of the pulley.

When the table is set in motion by an assistant turning the wheel, the potter takes a lump of the clay and *throws* it on to the centre of the table. Being provided with a vessel of water close at hand, he frequently dips his fingers in this, and then proceeds to form the clay into a rude form



suitable to the required shape of the article, and with certain wooden tools of varied forms (which are used wet) he then fashions the clay to the proper form. This operation in many cases occupies but a few moments of time. The potter now takes a piece of thin wire, with a handle at each end, which he passes below the model and disconnects it from the table. The vessel thus rudely fashioned is set aside to dry gradually to a certain extent; it is then taken to a *turning-lathe*, where it is made to adhere, by being moistened, to a wooden chuck moving vertically, as in wood-turning. The vessel is now turned neatly to its

proper shape by means of a very sharp tool, which also renders it smooth. A finishing touch is given with a steel burnisher.

The condition of dryness which enables the vessel to be turned in the lathe is also suitable for attaching the handles or appendages to the vessels. The handles, etc., being previously prepared, are united to the vessel by means of a thin paste of clay called "slip," and the seams are rendered smooth with a piece of wet sponge. The vessels are next placed in a stove-room heated to about 80° or 90° Fahr. When perfectly dried, they are brushed over with a small bundle of hemp, if the articles are fine, and they are afterwards removed to the kiln, which converts the soft clay into what is termed the *biscuit*.

Vessels which from their peculiar form cannot be turned at a lathe, are either *cast* or *pressed*. Press-work is effected in moulds made of plaster of Paris : one-half of the pattern is formed in one side of the mould, and the other half in the other side. Teapot handles, oval and square vessels, are made in plaster moulds. The clay is squeezed through different-shaped orifices at the bottom of a pump-barrel, by means of a piston-rod worked by a screw. The dough thus assumes a worm-shape, and is cut to the proper length and bent to the required form.

Casting is also done in plaster moulds, but the clay is worked up into a thin pap or "slip," which is poured into the moulds, after the two halves have been nicely fitted together. The mould is thoroughly dried before the slip is poured in, and this enables it to absorb a considerable amount of the water contained in the thin clay pap. After the thin slip has remained in the mould for a short time, during which period *the clay nearest the mould* has

become stiff and doughy, the remainder of the thin pap is poured out, which leaves the moulded vessel hollow. The time for doing this is regulated according to the thickness required for the article being formed. It is obvious that if the clay pap only remain in the mould a very short time before the pouring out of the superfluous matter, the resulting shell, so to speak, of clay will be exceedingly thin. The cast articles thus formed are carefully dried in the "green state," as it is termed, and are afterwards united by means of slip to the vessels prepared to receive them. Imitation flowers, leaves, etc., as in Dresden china, may be produced in this way, but the operation requires, as will be readily understood, exceeding delicacy of treatment.

Glazing consists in applying *enamel,* in a semi-liquid form, to the surfaces of the stone or earthen ware, and this must, to be good, possess the same power of contraction and expansion as the material upon which it is applied. In Staffordshire three different glazes are employed; one for common pipeclay, another for the finer quality of pipeclay ware, to receive impressions called *printing body,* and a third for ware which has to be ornamented by painting. The first glaze is composed of whitelead 53 parts, Cornish stone 16 parts, ground flints 36 parts, and flint glass 4 parts. These ingredients, excepting the whitelead, are ground to a fine powder and made into a thin paste with water.

The glaze to be printed upon in metallic colours consists of white felspar 26 parts, fused or "fritted" with soda 6 parts, nitre 2 parts, and borax 1 part. To each 20 lbs. of this "frit" are added 26 parts of felspar, 20 parts of whitelead, 6 of ground flints, 4 of chalk, 1 part of oxide of tin,

and a small quantity of oxide of cobalt to remove the brown tint and give a faint azure hue to the enamel.

Stoneware which has to be painted is covered with a glaze composed of the above printing colour frit 13 parts, to which are added redlead 50 parts, whitelead 40 parts, flint 12 parts, the whole being well ground together.

When the vessels are removed from the kiln in which they are baked, they are transferred to an apartment in which the enamel-tub is kept. They are then first dusted with a brush to remove particles of dust or grit, and are then dipped in the glaze-cream; they are then removed by the enameller, who shakes off the superfluous enamel, and then places them in the glaze-kiln, where they are subjected to a heat sufficient to fuse the enamel. Ure thus describes a Staffordshire glaze-kiln, and the precautions adopted to determine the proper heat for baking the enamel:—

"**Glaze-kiln.**—This is usually smaller than the biscuit-kiln, and contains no more than forty or forty-five bungs or columns, each composed of sixteen or seventeen saggers. Those of the first bung rest upon round tiles, and are well luted together with a finely ground fireclay of only moderate cohesion; those of the second bung are supported by an additional tile. The lower saggers contain the cream-coloured articles, in which the glaze is softer than that which covers the blue printed ware; this being always placed in the intervals between the furnaces, and in the uppermost saggers of the columns. The bottom of the kiln, where the glazed ware is not baked, is occupied by printed biscuit-ware.

"Pyrometric balls of red clay, coated with a very fusible lead enamel, are employed in the English potteries to ascertain the temperature of the glaze-kilns. This enamel

is so rich, and the clay upon which it is spread is so fine-grained and compact, that even when exposed for three hours to the briskest flame, it does not lose its lustre. The colour of the clay alone changes, whereby the workman is enabled to judge of the degree of heat within the kiln. At first the balls have a pale-red appearance; but they become browner with the increase of temperature. The balls, when of a slightly dark-red colour, indicate the degree of baking for the hard glaze of pipeclay-ware; but if they become dark brown, the glaze will be much too hard, being that suited for *ironstone*-ware; lastly, when they acquire an almost black hue, they show a degree of heat suited to the formation of a glaze upon porcelain.

"The *glazer* provides himself at each round with a stock of these ball *watches*, reserved from the preceding baking to serve as objects of comparison; and he never slackens the firing till he has obtained the same depth of shade, or even somewhat more; for it may be remarked that the more rounds a glaze-kiln has made, the browner the balls are apt to become. A new kiln bakes a round of enamel-ware sooner than an old one, as also with less fuel and at a lower temperature. The watch-balls of these first rounds have generally not so deep a colour as if they were tried in a furnace three or four months old. After this period cracks begin to appear in the furnaces; the horizontal flues get partially obstructed, the joinings of the brick-work become loose; in consequence of which there is a loss of heat and waste of fuel; the baking of the glaze takes a longer time, and the pyrometric balls assume a different shade from what they had on being taken out of the new kiln, so that the first watches are of no comparable

use after two months. The baking of enamel is commenced at a low temperature, and the heat is progressively increased; when it reaches the melting point of a glaze, it must be maintained steadily, and the furnace mouths be carefully looked after, lest the heat should be suffered to fall. The firing is continued fourteen hours, and then gradually lowered by slight additions of fuel; after which the kiln is allowed from five to six hours to cool."

Printing under the stoneware glaze is accomplished as follows: Cobalt blue is generally employed as the colouring matter, and the oxide of this metal is first mixed with a certain quantity of sulphate of baryta and ground flints, which are first calcined and then ground, after which the mixture is combined with a flux consisting of equal parts by weight of ground flints and flint glass reduced to fine powder.

The above mixture is ground on a porphyry slab with thick boiled linseed oil, resin, tar, and oil of amber. This forms a very tenacious compound, which can only be used with the application of heat, which is done by spreading it upon a hot cast-iron plate. The printing plates, which are made of copper, are engraved with moderately deep lines. The printer spreads his colour upon the hot engraved plate, and removes any excess of colour with a palette-knife. He then takes the paper to be printed upon and soaks it in soap-and-water, and while still moist, he lays it on the engraved plate. The plate is next passed through a press, the proof-leaf is lifted off and handed to women, who cut the impression into detached pieces, which they place on the surface of the ware. The figures on the impressed paper readily become attached to the biscuit-ware, owing to the tenacious character of the varnish, and the pressure

which is given, by means of a roll of flannel, by the women employed in the task. After the design has thus been fixed on the ware, it is set aside for a while to enable the colour to become thoroughly attached. The article is afterwards plunged into water, and the paper is removed with a piece of sponge, leaving the colour on the surface. After the paper is removed, the ware is dipped into caustic ley, which dissolves the oil; it is finally dipped in the glaze-liquor, with which the figures adhere readily.

The various *metallic lustres* which are applied to stoneware vary according to the metal used to produce the desired effect.

Platinum lustre.—Platinum is dissolved in 2 parts of hydrochloric acid and 1 part nitric acid. When the solution is cool, spirit of tar, made by boiling equal parts of tar and sulphur in linseed oil, is added, drop by drop, with continual stirring. The strength of this mixture is regulated according to the effect to be produced. When the solution is rich in platinum, the ware, coated with it, and afterwards heated in a "muffle" furnace, assumes the lustre of steel. The oxide of platinum is employed to produce a *silver lustre*, by brushing it evenly over the surface of the ware, after which the ware is put into the muffle-kiln; a second coating of the metallic lustre is sometimes given to heighten the effect.

Gold lustre is produced by adding to a solution of chloride of gold (made by dissolving gold in aqua regia) a few grains of grain tin. A mixture is next prepared consisting of "balsam" of sulphur, prepared as before described, to which a little essence of turpentine is added. After being well worked up together, this mixture is to be added to the solution of gold and tin, drop by drop, with continual

stirring. This lustre must only be applied to enamel or glaze which has already passed through the fire.

Unglazed pottery.—This kind of ware, so long identified with the famous name of Wedgewood, consists in mixing baryta with the clays, which acts as a flux, forming a semi-vitrified surface of great hardness. Wedgewood ware is thus prepared: The composition of the vitrifying pastes suitable for receiving all kinds of metallic colours is sulphate of baryta, 47; felspar, 15; Devonshire clay, 26; sulphate of lime, 6; flints, 15; and sulphate of strontia, 10 parts. Gold precipitated by tin, as before, produces a rose colour; manganese, a dark-purple colour; antimony, an orange colour; copper, browns and dark greens; cobalt, various shades of blue; and nickel with potash, greenish tints. The fine Wedgewood ware blue is produced by oxide of cobalt. Black Wedgewood ware is produced by the black oxides of manganese and iron.

English china is sometimes composed of Cornish stone, 60 parts; kaolin (China clay), 40 parts; and flint glass, 2 parts: or felspar and China clay, of each 40 parts; ground flints, 10 parts; and flint glass, 8 parts. The glaze for the first of these compositions is felspar, 20 parts; flint, 15 parts; redlead, 6 parts; and soda, 5 parts. These are first "fritted"—that is, calcined without fusion—and to 44 parts of the frit are added flint glass 22, and whitelead 15 parts, the whole being well ground together. The glaze for the second composition is composed of flint glass, 8; felspar, 36; whitelead, 40; and ground flints, 20 parts.

Porcelain.—This beautiful kind of pottery-ware is prepared from the finest kaolin, or China clay, with a siliceous flux for the *hard* porcelain, while the *tender*

ware is composed of a vitreous frit made opaque by the addition of calcareous or marly clay. Artificial glass, composed of silicate of soda, or potash, and lead is used as a glaze.

The celebrated Sèvres porcelain is generally composed of China clay and of a decomposed felspar rock, resembling the clay of Cornwall and the Cornish stone. The proportions of materials employed at the manufactories of Sèvres for ware which is to be glazed are thus given: Silica, 59; alumina, 35·2; potash, 2·2; lime, 3·3 parts. The glaze is made of solid felspar calcined, ground, and washed. The kaolin is washed at the pit from which it is obtained, and is sent in this condition to the factories of Sèvres, where it is again carefully washed to free it from coarser particles, and finally passed through very fine sieves. To this prepared clay the ground felspar rock is added in certain proportions, and the mixture is then deprived of a chief part of its water, after which it is set aside for many months in damp cellars.

When required for use it is first dried and pulverized, and then slightly moistened; it is then placed on a floor and is trodden upon by a barefooted workman for a considerable time. This operation is found to increase the plasticity of the material. After this treatment it is moistened and formed into lumps, when it is ready for the potter's lathe. Being not so plastic as stoneware dough, it requires considerable care in handling, which is supposed to be one cause of the high price of porcelain as compared with stoneware pottery.

The round plates and dishes are shaped on plaster moulds, but sometimes the paste is laid on as a crust, and at others it is turned into shape on the lathe. When a crust is

to be made, a moistened sheepskin is spread on a marble table, and over this the dough is extended with a rolling-pin, supported on two guide-rules. The crust is then transferred over the plaster mould by lifting it upon the skin; for it wants tenacity to bear raising by itself. When the piece is to be fashioned on the lathe, a lump of the dough is thrown on the centre of the horizontal wooden disc, and turned into form as directed in treating stoneware, only it must be left much thicker than in its finished state. After it dries to a certain degree on the plaster mould, the workman replaces it on the lathe, by moistening it on its base with a wet sponge, and finishes its form with an iron tool. A good workman at Sèvres makes no more than from fifteen to twenty porcelain plates in a day, whereas an English potter with two boys makes from one thousand to one thousand two hundred plates of stoneware in the same time. The pieces which are not round are shaped in plaster moulds, and finished by hand. When the articles are very large, as washhand-basins, salads, etc., a flat cake is spread above a skin on the marble slab, which is then applied to the mould with the sponge, as for plates; and they are finished by hand.

"The projecting pieces, such as handles, beaks, spouts, and ornaments, are moulded and adjusted separately; and are cemented to the bodies of chinaware with slip, or porcelain dough thinned with water. In fact, the mechanical processes with porcelain and the finer stoneware are substantially the same, only they require more time and greater nicety. The least defect in the fabrication, the smallest bit added, an unequal pressure, the cracks of the moulds, although well repaired, and seemingly effaced in the clay shape, reappear after it is baked. The articles

should be allowed to dry very slowly; if hurried but a little, they are liable to be spoiled. When quite dry they are taken to the kiln" (Ure).

Tender porcelain, or soft chinaware of Sèvres, is composed of a frit made of nitre, sea-salt, soda, alum, gypsum, and sand or ground flints. These are partially fused or fritted in a furnace, with constant stirring, so as to form a spongy mass. This is afterwards reduced to powder, and to each 3 parts of this frit 1 of the white marl of Argenteuil is added, and the whole well ground together and worked up into a paste with gum-water, which gives it sufficient plasticity to be handled. This tender paste can only be moulded in the first instance, as it will not bear turning in the lathe. The articles are first formed in moulds of plaster, much thicker than required to be when finished, and after being dried they are finished at the lathe with metal tools, after which they are baked; but owing to the extreme softness which this porcelain acquires during the process of baking, saucers, plates, and similar articles require to be supported on earthen moulds. During the baking process their position is reversed, so as to prevent them from assuming an irregular form.

In a work of this character it is impossible to enter more fully into the details of the manufacture, but it is hoped that the information given may prove sufficient to enable the reader to understand the principle upon which this important art is conducted.

RUSTIC FLOWER-VASES.

The following happy suggestion of the late Sir Joseph Paxton, whose name will ever be agreeably associated

with the Great Exhibition of 1851, has been more or less adopted throughout the country, but not to an extent which would have satisfied the eye of the gifted landscape-gardener: "The introduction of vases even of a rustic character into cottage gardens will by many be considered a startling proposition; but we can conceive nothing which would so alter the appearance of a cottage front, or that would tend to give so elevated a character and so attractive an appearance, as a rustic vase, . . . if judiciously filled with pelargoniums, fuchsias, or roses, in the centre, and surrounded by plants of a drooping habit, allowed to hang over the sides." Now this idea suggests to the mind a myriad ways in which rustic vases may be fashioned at little cost by any one who has acquired the happy knack of handling ordinary carpenters' tools; and indeed we have frequently constructed such garden ornaments in the course of an hour or two, which were afterwards filled with good potting mould, over a layer of broken potsherds, and the vases furnished with plants appropriately grouped, presenting a very pleasing relief to other objects in the flower-garden. The following rough sketches will give an idea of the simplicity and ease with which rustic vases may be made by the amateur gardener.

Fig. 1 represents a small butter-tub, perforated at its bottom by several holes, and secured to a forked branch of a tree, inserted so as to form a strong yet graceful support. The part of the branch upon which the tub rests is cut evenly, so that the vessel may stand perfectly upright, and this may be secured to the support by means of three 2-inch screws. In the first instance, it is well to fix the prongs of the branch, which should be of sufficient length for the

purpose, in the soil at the spot selected for its position. It should be sunk in the earth at least 18 inches, and with the aid of old bricks, or large stones, mixed with earth, it should be rammed down tight, so as to be firmly set. After this is done and the tub properly screwed to its place, pieces of "virgin cork" of nearly uniform length and width are placed round the tub, and fastened by ordinary cut nails. These pieces of cork must be allowed to project both above and beneath the vessel about 2 inches. In selecting the cork for this purpose but little

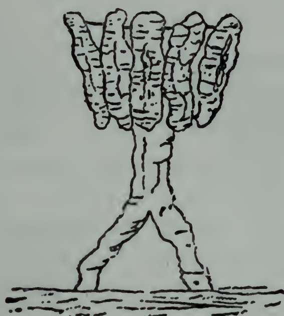


Fig. 1.

difficulty will be experienced in securing suitable pieces, and these may readily be cut, or, still better, broken off to the required size. Rigid uniformity should be avoided, for the vase will look better as a whole if the outer lining of cork presents a rugged and irregular appearance.

In preparing these rustic vases for plants, a layer of broken fragments of flower-pots should first be spread over the bottom of the tub, then a layer of leaf-mould, and above this a compost made with good light soil, well-rotted

vegetable matter, and silver sand, with the addition of a small quantity of loam. Plants that will not thrive in this compost ought to be ashamed of themselves.

Fig. 2 is a shallow wooden box, perforated at the bottom for drainage, and attached to a tree stump, as before; the sides of the box may be ornamented by short lengths of crooked wood cut from branches of an old tree.

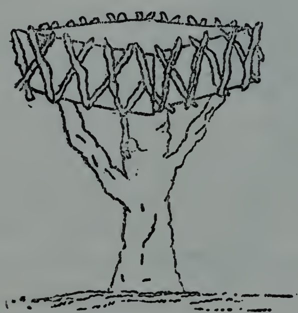


Fig. 2.

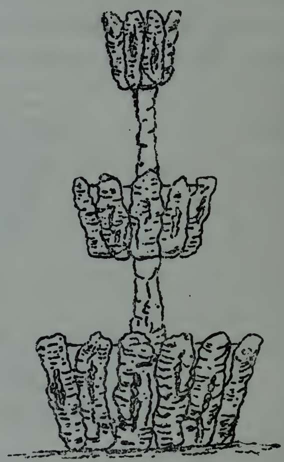


Fig. 3.

The required number of lengths may first be cut off, and these should afterwards be cut in half longitudinally, so that when the two halves are placed crosswise, they may nearly match in form.

Fig. 3 represents what we may call *a floral whatnot,* and may be thus formed: A stout branch of a tree cut off transversely at its base is first driven into the ground as before. A moderate-sized tub is then selected, and a hole cut in the centre of the bottom sufficiently large to admit

the branch, over which it is now slipped, and allowed to rest on the ground. A second and smaller tub is next to be screwed on to the flat face of the branch. A smaller branch is next selected and cut to a suitable length. Upon the lower end of this a piece of stout board is screwed or nailed, to act as a support, when this is placed upright in the second or middle tub. The upper end of this branch should be cut level, and another stout piece of board, cut into an octagon form, firmly nailed to it. If suitable lengths of virgin cork are now nailed round this, and secured by thin copper wire at the upper joints, a receptacle for an ordinary flower-pot will be at once formed. The drawing will give an idea as to the ornamentation of the tubs by means of cork.

WATERPROOF CLOTH.

There are many ways of rendering cloth impervious to water while still allowing the air to pass through its pores. A solution of isinglass, alum, and soap has been successfully used for this purpose. The solution is applied with a brush on the wrong side of the cloth while stretched on a board. When dry it is again brushed over on the wrong side and against the grain of the cloth. The brush is afterwards dipped in clean water and passed lightly over the cloth, and the glossy appearance which the cloth thus assumes can be removed by brushing the cloth when dry.

Solutions of indiarubber in turpentine, followed by coatings of a solution composed of sugar of lead, litharge, sulphate of zinc, with gum mastic and turpentine, have also been used for the purpose of rendering cloth imper-

vious to moisture. The surface thus prepared is afterwards covered with wool, or other material of which the fabric is made, cut into proper lengths and attached to the fabric by means of pressure, by which a pile or nap is formed.

Cooley gives the following recipe for waterproofing, which appears to have the advantage of having been tried —with success :—

"A simple method of rendering cloth waterproof, without being airproof, is to spread it on any smooth surface and to rub the wrong side with a lump of bees'-wax (perfectly pure and free from grease) until it presents a slight, but even, white or greyish appearance; a hot iron is then to be passed over it, and the cloth being brushed whilst warm the process is complete. When this operation has been skilfully performed a candle may be blown out through the cloth, if coarse, and yet a piece of the same placed across an inverted hat may have several glassfuls of water poured into the hollow formed by it, without any of the liquid passing through. Pressure or friction will alone make it do so. We have shown this to numerous cloth manufacturers, waterproofers, tailors, and others, several of whom have adopted the method very extensively, and with perfect success."

PRUNING TREES AND SHRUBS.

As a mechanical operation, the art of pruning requires both judgment and skill; and when we consider that the fruit-bearing power of trees and shrubs depends greatly upon the judicious application of the knife in due season and in a systematic manner, it will be conceded that the

subject is worthy of special attention. Loudon thus gives directions for pruning from a scientific point of view which will be readily understood even by those who have not devoted much attention to the subject: "In the operation of pruning, the shoots are cut off close to the buds, or at a distance not greater than the diameter of the branch to be cut off; because without the near proximity of a bud, the wounds will not heal over. In shoots which produce their buds alternately, the cut is made at the back of the bud, sloping from it so that it may be readily covered by the bark in the same or in the following year; but in the case of branches where the buds are produced opposite each other, either one bud must be sacrificed or the branch must be cut at right angles to its line of direction, which is most conveniently done with the pruning-shears."

The following practical instructions for pruning were given by the late Sir Joseph Paxton, and will be read with interest by all lovers of the orchard and its produce:—

"The pruning of fruit-trees and bushes is sadly neglected in most cottage-gardens, the trees often presenting a complete wilderness of crowded branches, producing in some seasons great numbers of small, worthless fruit, and in others failing entirely; besides, by their impenetrable shade, permitting nothing to grow beneath them. One great cause of these evils is want of pruning; therefore, those who do not understand the principle of pruning will do well to thin out yearly, at this season (autumn), the weak spray wood, and removing all branches that cross each other, leaving the trees and bushes regular and uniform, and keeping them open in the centre; for although they do not cut so judiciously as a practised gardener would,

they will find, nevertheless, that they have done a great deal of good, which will be apparent in the increased health and fruitfulness of their trees. After standards have become old, this thinning and regulating is all that is required; but pruning should be commenced in the early stage of a tree's growth, for if it becomes necessary to remove large branches the tree suffers by it, and it tells of previous bad management; therefore do not suffer any branches to remain in your young trees which you know it will be necessary to remove hereafter. In pruning dwarf standard apple-trees, cut back until sufficient shoots are produced to form main branches, which may be trained out to the proper form by placing two hoops of the desired width in the centre of the tree, training the young main branches over on their outside; in the early career of the tree, these young vigorous shoots should not be much pruned back, but only their unripened points removed, always looking at the direction of the eye before the cut is made, as the form of the tree will depend upon this. If this is neglected, perhaps the shoot may grow sideways, or, what is worse, inwardly; therefore always prune to a bud that points outwardly; this should be attended to in every species of pruning.

"When your trees have arrived at the desired height, nothing more will be required than to prune the top shoots close off every year, and the side ones to one or two eyes; by which means an abundance of fruit-spurs will soon be formed; and from trees kept thin in this manner the finest fruit is obtained, besides the great advantage of their occupying little room. Dwarf pears, of some of the best kinds, should also be procured to be trained like pyramids—that is, one straight stem

made to throw out numerous side branches up its whole length by yearly heading it back; which side branches are tied down to each other, making them assume a pendent or weeping form; by this means some of the choicer pears may be grown to great perfection without occupying much space. Pears do not become fruitful if severely pruned, which should, therefore, be confined to thinning out the young branches in July, leaving little to be done now, shortening only in cases where a supply of young shoots is required; but the things on which fruitfulness most depends are their first planting, and after root-pruning when necessary. First, then, in planting, the roots must by no means be buried deeply, and in wet situations, or retentive clayey soils, they should be rather raised into a little mound above the surrounding surface; the holes should be dug wide, say 4 feet, and deep enough to admit being partly filled up with stones, brickbats, or some material that will prevent the roots penetrating deep into the subsoil and serve as drainage at the same time; 2 feet will be sufficient depth of soil. This precaution will contribute to the health of the trees, bring them to a bearing state at a much earlier age, and materially improve the quality of the fruit. The strong tap-roots, if any, should be pruned off at the time of planting, and the others laid out carefully; if, after this, there may seem any disposition in the trees to grow too strong, the roots must be cut off with a sharp spade all round at about a yard from the stem; and any established unfruitful trees may be treated in the same manner, which will cause them immediately to form fruit-buds: by this system a mass of healthy fibrous roots is produced near the stem, enabling you to dig and crop near the trees without injuring them;

and any mulching with dung, or watering when necessary, is sure to have the desired effect, from the certainty of the range of the roots.

"It cannot be too strongly borne in mind in lifting trees, that it is the small roots which chiefly supply nourishment to the plant; too much care cannot, therefore, be taken to preserve them from injury in the removal; and the little additional labour this may cost over removing them carefully, will probably be repaid by a crop of fruit a season earlier, or, at all events, by success in the operation. Unless the tree is too thick with wood, there is no necessity for removing branches on account of transplanting, or, at least, only as many as may seem equivalent to the loss of roots, which, with care, will be little or nothing. When the trees have begun to grow again, they may be regulated, by taking out, or shortening only, the weakest shoots. What is termed spur-pruning is the best system for outdoor grapes—that is, leaving only one or two eyes of the last year's wood on the main branches, and a few short rods, four or five eyes each, in situations where it may seem expedient to replace an old shoot, or cut one down at some future time, which should always be considered, as by this means your vine may be kept furnished with young, healthy, fruit-bearing branches, even where the space intended to be covered is considerable. The young wood at the end of the main stems should not be left too long, as some are apt to leave them, thinking to gain time; or the consequence will be that the lower part of the vine will become weakened, and its regularity destroyed by the upper eyes breaking strongly, and the lower ones feebly: endeavour rather to have a regular distribution of young wood by

short rods throughout the tree without crowding, which is a great fault.

"The neatest and best plan for training is to carry the main stem horizontally near the ground, into which it may be allowed to dip and root, if the distance it has to go is considerable, taking up from it, at regular intervals, perpendicular main branches. Some of the strongest, straightest, and best-ripened cuttings of gooseberries and currants may be planted, previously picking out all the eyes quite clean except three or four of the terminal ones; they may be reduced to about a foot long; by removing a portion of their unripened points, and by picking out the eyes, the bushes are prevented from throwing up suckers. Bushes with about 1 foot of stem look much better, besides, in some measure, assisting to prevent the fruit becoming dirted by heavy rains. Neither prune nor transplant during frosty weather; dull, mild weather being the best."

In pruning currant and gooseberry bushes, all branches which have good buds should be retained, as also all well-ripened shoots. Meagre and half-ripened shoots should be cut away to within an inch of the branch. All erect shoots must be removed except when required to fill up any space which may be bare of wood. Every awkward and thick shoot should be cut away close to the stem. The shoots should not be suffered to grow too close together, but each have ample room. When it is desired to provide a future stock of young bushes, the best and strongest shoots removed by the pruning-knife or shears should have all their lower buds stripped off, with the exception of four top buds, and the shoots may be at once stuck in the soil in a shady border. By the following

autumn, if all goes well, the shoots will have well rooted, and have at least two good shoots at the top. These should be cut down so as to leave about four eyes or buds on each.

It is commonly the practice, in pruning roses, to perform the operation at two different intervals—the first cutting being made at any favourable opportunity between December and February, and a final cutting after the spring growth has vigorously set in. Bearing in mind that the flowering buds make their appearance only on the vigorous young wood, the pruning should be so managed as to leave only one or two good buds at the base of each healthy shoot. All old and sickly wood should be cleared away.

COTTON WADDING.

This well-known and useful material is made by attaching carded cotton to tissue paper previously coated with size, which is prepared by boiling the cuttings of hare-skins and adding a small quantity of alum to the solution. The sheets of wadding sold at the shops consist of two sheets, prepared as above, placed face to face, by which a very soft wadding is formed of good thickness, but of exceeding lightness. When these sheets are separated, by being carefully pulled asunder, they form very useful coverings for plated or silver articles to prevent them from tarnishing when not in use. The other useful purposes to which wadding is applied are too well known to need recapitulation.

MANUFACTURE OF BRASS.

This important alloy of copper and zinc is largely manufactured in Birmingham and Berlin. A vast number of useful and ornamental articles are made from it, and indeed from the great extent of its application, it may fairly be considered the most important alloy known to the arts.

The brass of the ancients was an alloy of copper and tin, resembling the alloy now generally known as bronze. The alloying of copper with zinc appears to have been practised to some extent about fifty years before the Christian era, but it was not until some centuries after that its manufacture became fully developed.

Brass was formerly made by placing in a crucible granulated copper, called *bean-shot*, or copper clippings, with calcined native carbonate of zinc and charcoal, and exposing them to strong heat. This plan was afterwards superseded by plunging strips of copper into melted zinc. The copper readily unites with the molten metal, and fresh quantities are added until an alloy, not easily fused, is formed. This is afterwards broken up into fragments, and remelted under a layer of charcoal, with the addition of either metal to bring the alloy up to the colour and standard required. The alloy is then cast in granite moulds, which are preferred to those made from any other material. It is afterwards annealed, and when cold is passed through rollers, and thus converted into thin sheets of any desired gauge.

Sometimes brass is made by pouring the two metals, zinc and copper, together when in a melted state, *very quickly*, and with vigorous stirring at the time.

For making the best quality of brass, 2 parts of copper to 1 of zinc are employed; but the bright yellow brass

formerly known as Prince's or Prince Rupert's metal consists of about 2 parts of zinc to 1 of copper.

Fine malleable brass for sheets, tubes, etc., is made from various formulæ. I. Copper, 7 parts; zinc, 3 parts. II. Fine copper, 4 parts; zinc, 1 part. III. Copper, 33 parts; zinc, 25 parts. IV. Copper, 3 parts; zinc, 2 parts. These are malleable whilst hot.

Red brass contains only a small percentage of zinc, sometimes as little as 8 or 10 per cent.

Brass for castings.—The alloy for fine brass is sometimes used for superior castings, or either of the following: I. Copper, 62 parts; zinc, 35 parts; lead, 2 parts; tin, 1 part. II. Copper, 60; zinc, 36; tin, 4 parts. These alloys are rather brittle, and of a palish colour. III. Copper, 90 parts; zinc, 7 parts; tin, 2 parts; lead, 1 part.

Gilding metal.—I. Copper, 64 parts; zinc, 32 parts; lead, 3 parts; tin, 1 part. II. Copper, 82; zinc, 18; lead, 1; and tin, 3 parts.

Brass for turning.—I. Copper, 65 parts; zinc, 33 parts; lead, 2 parts. II. Fine brass, 98; lead, 2 parts, melted together. III. Copper, 61; zinc, 36; lead, 3 parts.

Brass solder.—I. Brass, 3 parts; zinc, 1 part. This is used for soldering tubes and joints, and for all purposes where great strength is required. II. Fine brass, 12; zinc, 6; tin, 1 part, united together by fusion.

Brass for wire is made from copper, 72 parts, and zinc, 28 parts; or copper, 64, and zinc, 34 parts. In making wire from either of these alloys the metal is first annealed; and it is subjected to the same process frequently during the operation of drawing into wire.

Button brass, or **platin** of the Birmingham manufacturers, is composed of 8 parts of brass and 5 parts of zinc,

while their cheaper button-metal is composed of copper, tin, zinc, and lead.

Dutch metal, from which Dutch gold-leaf is made, is an alloy of copper, 11 parts; zinc, 2 parts.

Pinchbeck, similor, and **Mannheim gold** are names given to an alloy similar to Prince's metal (which see).

When the alloy for malleable brass has been cast into plates, it is usual to cut these into ribbons of various breadths (commonly about 6½ inches). This is done by powerful machinery, and the ribbons are first passed through the cylinders of the rolling-press while cold; but as the pressure of the rollers hardens the metal considerably it requires to be annealed in a furnace, after which, *when cold,* it is again passed through the rollers. The rough edges of the plates are then trimmed in a suitable machine, and now two plates are rolled at a time, the annealing process being occasionally repeated. When very thin sheets are required, sometimes as many as eight plates are passed through the rollers at one time. The annealing of the sheets in the furnace requires great care, and must be done with perfect uniformity, otherwise they will not roll out equally. The plates are placed one above another, with clippings of brass between each, so as to allow the heated air to pass between them. The annealing-furnaces are commonly about 32 feet long by 6½ feet wide. The sheets, which are sometimes 24 feet long, are placed in the furnace and removed together. For this purpose an iron carriage nearly as long as the furnace is employed. Upon this the sheets are laid, and the carriage is brought to the height of the furnace door by means of a crane. Two such carriages are used in order to avoid loss

of furnace-heat; one of these is employed to convey the sheets *to* the furnace, and the other *from* it.

Dutch leaf, which is so extensively used as a substitute for leaf-gold for "gilding" cheap picture-frames and other purposes, is made from very thin brass beaten out by a hammer worked by steam-power. The hammer gives from three hundred to four hundred strokes per minute. From forty to eighty leaves are laid over each other, by which means the metal acquires the required lustre.

SOLDERING.

The art of uniting two different metals, or parts of the same metal, so as to form a perfect union, requires both knowledge and skill for its perfect accomplishment. The "solder" employed depends upon the nature of the metal or metals to be joined, and the subsequent usage to which the soldered article may be subject.

Hard soldering, for brass tubings, and for uniting other brass surfaces, consists in first scraping or cleaning the parts to be united, and then applying, with a camel-hair brush, a thick paste made with powdered borax and water, or by rubbing a lump of this substance upon a piece of slate, moistened with water: the creamy condition which the borax assumes when thus rubbed up renders it very easy to apply to small surfaces. The solder (see p. 93) is obtained in the form of small grains, and these are spread thinly upon the part to be joined, after which the object is submitted to a full red-heat, when the solder "runs" into the intermediate space, forming a perfect junction. The moment the solder has fairly run the article is removed from the fire. In *brazing,* as this

process is called, sometimes it is necessary to employ solder which melts at a lower temperature than the ordinary "hard solder;" in this case a larger amount of zinc is added, with also a little tin.

Hard soldering is also applied to gold and silver, but in these cases silver solder and gold solder are used respectively. The former is composed of silver, 2 parts, and brass, 1 part, melted together and rolled or hammered out into thin plates, which are afterwards scraped clean and cut into small fragments for use. Borax paste is applied to the surface to be united, and small pieces of the solder laid upon the spot. A gentle heat is first given with the blow-pipe, to expel the water from the borax, after which the heat is raised to a cherry redness until the solder runs, when the blow-pipe flame is promptly withdrawn.

Gold solder varies according to the standard or quality of the gold of which the article is made; the solder is composed of gold, silver, and copper in varied proportions:* that used for soldering 22-carat gold consists of gold, 18 dwt. 8 grains; silver, 16 grains; and copper, 1 dwt. The silver and copper are first melted together, with the aid of a little borax as a flux, after which the gold is added.

Coppersmiths' solder is composed of 8 parts of brass and 1 part of zinc, the latter being added to the former when in a melted state. The alloy is afterwards *granulated* by being poured into water, upon the surface of which short twigs or pieces of straw are allowed to float to assist the separation of the metal into granules.

Tin-plate, or vessels made from sheet tin, are soldered with an alloy consisting of tin, 2 parts; lead, 1 part.

* The alloys of gold, and the formulæ for the proper solder to be used for each, are given in "Scientific Industries," p. 37, etc.

Pewter is soldered with a still more fusible alloy, formed by adding bismuth to the above in various proportions to suit the nature of the article to which it is applied.

Soft soldering, as it is termed, consists in applying the alloy of tin and lead given above to articles made of tin, lead, zinc, and sometimes iron. In applying this solder to the two first-named metals, rosin and sal-ammoniac are employed to the parts to be soldered, to protect them from oxidation, and to assist the running of the solder. In soldering zinc, however, it is necessary to apply muriatic acid to the part, which may be done with a feather, and which, forming chloride of zinc, enables the solder at once to become alloyed with the metal, to which copper or other metal may be joined. When applying soft solder, or "pewter solder," as it is sometimes called, to iron the *chloride of zinc* is used; and this is previously prepared by putting small strips of zinc in a vessel and pouring upon them a little muriatic acid. In the course of a few minutes the solution is ready for use, and may be applied to the parts to be soldered by means of the feather end of a quill.

Sheets of lead may be united, without the aid of solder, by what is called the *autogenous* process. It consists in fusing two surfaces of the metal together, after being scraped clean, by means of a jet of hydrogen gas, or this gas mixed with common air. This process is sometimes called "burning" the joints, by mechanics who practise it. In lining wooden tanks with lead it is sometimes of great importance that no other metal should be in contact with the lead; the above process is in this case admirably suited to make perfectly sound joints without the aid of solder in any form.

BRICK-MAKING.

Like all other arts practised by what is called "rule o' thumb," the art of brick-making varies considerably, not only in the process of manufacture—if such it may be called—but in the article produced. Indeed, while there are thousands of fairly good bricks annually made, there are hundreds of thousands produced which are all but worthless.

There are two kinds of clay used in ordinary brick-making, one a stiff clay, which produces a hard, red brick, and the other a yellow, loamy earth, which makes a grey-coloured brick.

In preparing the clay for brick-making it is usually dug up in the autumn, and is allowed to lie exposed to the action of the air during winter. It is frequently turned or worked about during this period with a spade. In the following spring the clay lumps are broken up and thrown into a pit, soaked with water, and left for several days. The clay is afterwards worked up, or tempered, by kneading in a horse-mill. The kneading of the clay, although a tedious process, is of considerable importance, and much of the success of brick-making depends upon the care with which this has been accomplished. London brickmakers add sifted cinder ashes, in the proportion of about one-third, to the clay. When the material is sufficiently kneaded it is taken to the bench by the moulder, who takes up a lump in both hands, which he throws into the mould, removing the superfluous material with a flat tool made for the purpose.

The moulds for brick-making are made of wood, and are ordinarily 10 inches long, 5 inches wide, and 3 inches

deep; and the bricks, when dry, are about 9 inches long, $4\frac{1}{2}$ inches wide, and $2\frac{1}{4}$ inches deep. It is considered that a clever moulder can mould from 4000 to 5000 bricks in a day. The moulded bricks are taken, as fast as made, by a boy, who puts them on a receiving-board placed on a wheel-barrow, and they are then taken to a workman, who stacks them carefully in rows, from which they are transferred, when sufficiently dry, to the *clamp*, or kiln, in which they are burned.

The clamps are made of the new bricks themselves; a foundation is first made with these, and the dried bricks are built up, layer after layer, till the required height is reached. A layer of coal-breeze about 2 or 3 inches thick is strewed between each layer of bricks. A perpendicular fireplace, about 3 feet high, is arranged at the western end of the clamp. The flues pass through the clamp, and are filled with wood, coals, and breeze. When the bricks are required to be burned quickly—that is, in about twenty or thirty days—the flues are placed about 6 feet apart, otherwise 9 feet is about the regular distance.

The ordinary varieties of bricks are *yellow marl bricks; red* and *grey stocks; place-bricks; clinkers and fire-bricks.* The place-bricks and stocks are used in ordinary wall-making; the yellow marls, being a very superior hard and well-burned brick, are chiefly used for the outside of dwelling-houses or other buildings.

"Floating bricks," says Dr. Ure, "are a very ancient invention: they are so light as to swim in water; and Pliny tells us that they were made at Marseilles; at Colento, in Spain; and at Pittane, in Asia. This invention, however, was completely lost until M. Fabbroni published a discovery of a method to imitate the floating bricks of the

ancients. According to Posidonius, these bricks are made of a kind of argillaceous earth, which was employed to clean silver plate. But as it could not be our tripoli, which is too heavy to float in water, M. Fabbroni tried several experiments with mineral agaric, guhr, lac-lunæ, and fossil-meal, which last was found to be the very substance of which he was in search. This earth is abundant in Tuscany, and is found near Casteldelpiano, in the territories of Sienna. According to the analysis of M. Fabbroni, it consists of 55 parts of siliceous earth, 15 of magnesia, 14 of water, 12 of alumina, 3 of lime, and 1 of iron. It exhales an argillaceous odour, and when sprinkled with water throws out a light whitish smoke. It is infusible in the fire; and though it loses about an eighth part of its weight, its bulk is scarcely diminished. Bricks composed of this substance, either baked or unbaked, float in water; and a twentieth part of clay may be added to their composition without taking away their property of swimming. These bricks resist water, unite perfectly with lime, are subject to no alteration from heat or cold, and the baked differ from the unbaked only in the sonorous quality which they have acquired from the fire. Their strength is little inferior to that of common bricks, but much greater in proportion to their weight; for M. Fabbroni found that a floating brick measuring 7 inches in length, 4½ in breadth, and 1 inch 8 lines in thickness, weighed only 14½ ounces; whereas a common brick weighed 5 lbs. 6¾ ounces. The use of these bricks may be very important in the construction of powder magazines and reverberatory furnaces, as they are such bad conductors of heat that one end may be red-hot while the other is held in the hand. They may also be employed for buildings that require to be

light; such as cooking-places in ships, and floating batteries, the parapets of which would be proof against red-hot bullets."

Besides the ordinary bricks referred to, *perforated bricks, glazed bricks, waterproof bricks,* and other ingenious modifications have from time to time been introduced, all more or less possessing some features of apparent advantage.

Fire-bricks, which are much employed for lining furnaces, retort-stoves, and all fireplaces subjected to great heat, are made from a refractory clay found in the neighbourhood of Stourbridge in Staffordshire. Crucibles for melting metals are also made from the same material.

EMERY-WHEELS.

There is no tool of more general use in a workshop or manufactory than a solid emery-wheel, and perhaps there is no tool so little understood.

If we may judge by the manner in which these wheels are sometimes mounted and used in workshops, the popular idea would seem to be, not only among ordinary, but good mechanics, that anything would do for an emery-wheel, so long as it was made to revolve at a high rate of speed, and the wheel able to stand any amount of abuse; to this fact is probably due many of the accidents from bursting of the wheels and other sources of annoyance and danger.

While it may be true that an emery-wheel carelessly mounted and improperly used may be useful and lucrative to a certain extent, it is also true that if it were mounted in a proper manner, and used with the care and attention given to any other tool, it would be far more useful and profitable.

The first requisite to the proper running of an emery-

wheel is the machine upon which it is mounted. This should be proportioned in weight and stability to the size of the emery-wheel, and also to the weight of the articles to be ground, always remembering that if the machine is too slight, perfect work will be impossible, whereas there will be no disadvantage in having the machine stronger or heavier than is necessary. The spindle should be large and well fitted to the bearings, which should be long and have no end play, otherwise the corners of the wheel may be knocked off; care must be taken that the faces of the flanges are at a right angle to the spindle. A little deviation will tend to break the emery-wheel when the flanges are brought together.

Wheels have often been known to crack or break from this cause, and sometimes to fly in pieces as soon as started, the operator being at a loss to account for the breakage in any other manner than that the emery-wheel was bad.

A packing of rubber cloth or thick paper should be inserted between the faces of the flanges and the wheel; this will tend to overcome any slight imperfection in the accuracy of the flanges, insure a better fit, and secure the wheel more firmly and with less pressure from the nut.

When the emery-wheel is secured between the flanges, it should run *perfectly* true, and should also be well balanced. If an emery-wheel, after being mounted perfectly true, is found to be out of balance, it should be immediately condemned or not used until it has been properly balanced; before condemning the wheel, however, it is well to see that the trouble does not lie in the spindle itself. The emery-wheel should never fit too tightly on the spindle, because the latter may become heated and expand, causing the emery-wheel to burst. It is better to have the hole

in the emery-wheel much larger than the spindle, and a packing inserted to reduce it to the proper size. This packing may be of soft metal melted and poured in, or a wooden socket secured by cement may be used. The practice of securing the emery-wheel to the spindle by means of a key is considered objectionable.

While considering the subject of emery-wheels, our attention was lately called to a new emery-wheel introduced by the Standard Emery-Wheel Company, of Greek Street, London, and by the courtesy of the manager we were enabled to see the wheels in full operation, and also the process of manufacture, which we may say is conducted with much ingenuity and care. The object of the company is to produce an emery-wheel which shall possess all the advantages of tenacity, quickness of cutting, and *safety*—that is, non-liability to crack or break; and in fairness to the patentee, we may state that these important conditions have been amply fulfilled.

The principle upon which a good emery-wheel should be constructed may be gleaned from the following statement: "It is necessary for perfect efficiency that the wheel shall cut freely, and neither glaze on the surface nor unduly heat the work. The particles of emery themselves, being extremely hard, sharp, and angular, are exactly suited for the duty required of them, as they cut cleanly without tearing or scraping (just as a sharply pointed steel tool will do more work with less loss of power by friction, and consequent heating, than will a tool with a blunt point); and further than this, the emery grains never become blunted, for as they wear away in use by minute angular fragments being broken off, a succession of sharp edges and points is constantly presented. It is, however,

extremely difficult to obtain a cementing material which, while possessing sufficient cohesive strength and adhesion to the emery, shall neither offer such resistance as to cause undue heating, nor distribute itself in a skin or glaze over the emery particles, and thus impair their cutting power. To take an example: glue or gelatine has been used as a matrix, and in some respects it fulfils the required conditions. It is sufficiently strong, adheres well to the emery, and is not too hard; but it has the fatal defect of clinging to and covering over the working faces of the emery grains instead of wearing away and keeping them clean. An emery-wheel made with glue or any kindred substance as a matrix would therefore be a *glazing-wheel*, and may be taken as an extreme type of several classes of wheels in which this has been the main defect. It is necessary, then, that the matrix when it wears away should leave the wheel in dust, and not continue to adhere to the surface after its duty has been performed. In avoiding this fault it is easy to fall into the opposite one of choosing a cementing material so hard and unyielding as to produce a large amount of *heat* in working, owing to the *friction and useless expenditure of force* occasioned by its too great resistance. Any matrix of a hard stony nature is subject to these objections, as well as that of brittleness, adverted to above in considering the question of safety; and sellers of emery-wheels of this kind have given indirect evidence of the fact by advocating lower rates of speed than is advantageous to use with wheels free from such defects; and also by advising the free use of water in grinding as a palliative."

It will thus be seen that an emery-wheel must be prepared with due regard to every detail necessary to render it not only effective as a grinding tool, but absolutely free

from liability to *break*. The danger to workmen from this cause is considerable with an emery-wheel of a brittle nature; and it must be gratifying to grinders to know that these important tools can now be obtained of such a character as not to endanger their personal safety. In order to give additional security to their wheels, the Standard Emery-Wheel Company attach a pair of safety-plates, one on each side of the wheel, set perfectly parallel, and with central holes, of the proper diameter to fit the spindle, bored accurately at right angles to their faces, by which the wheel must be accurately centred, and truly square with the axis of rotation, while the body of the wheel itself cannot touch the spindle. In fact, the safety-plates, and not the emery-wheel, are attached to the spindle, by which means the possibility of the bursting of the wheel by heating and expansion of the spindle is absolutely prevented. It must be understood that the "safety-plates" referred to do not correspond to the side plates ordinarily applied to common emery-wheels.

CASK-MAKING.

There are many systems adopted for making casks, but the following will give the reader a general idea of the principle upon which these useful vessels are constructed by the aid of suitable machinery. A circular saw is fixed to a strong bench, with a slide-rest upon which each piece of wood intended to form a stave is fixed. The rest slides forward in a curved direction, aided by an adjustable *guide*, which brings the timber against the edge of the circular saw, causing it to be cut in the curved form required for the edge of the stave. A machine with suitable cutters,

attached to a standard, traverses round with their carrier upon a centre, by which the upper and lower edges of the cask are cut round and grooved for the purpose of forming a suitable bed for the head of the cask. An apparatus is then brought into use by which the staves are cut to uniform length, and bevelled at either end. Another machine is employed, in which the cask is made to revolve upon an axis, and a cutting tool passes over the exterior of the cask to give it a smooth surface.

When the staves have been cut to proper length and form, they are then set round within a confining hoop at the bottom, and arranged in the form of a cask, after which they are held together by means of hoops placed temporarily over them. The cask is then placed in a frame upon a platform and raised by a lever, so that one end of the cask may come in contact with a series of cutters in a lathe above, which, traversing the interior of the cask to the extent of about 3 inches, cuts a circular groove, called the *chine*, into which the head of the cask is afterwards fixed. The cask is now reversed, and the opposite end is grooved, or chined, in the same way.

The *heads* of the cask are formed from pieces of wood, cut perfectly straight and laid side by side, after which they are cut to the required diameter by a revolving cutter. The cask is afterwards made up with hoops of various sizes, and the heads inserted, after which the hoops are driven tight, and the cask is complete.

FULLERS' EARTH.

This peculiar clay, which occurs largely in some parts of Berkshire, Surrey, and other counties, is extensively

used in the cleansing of woollen stuffs, in the manufacture of cloth, and for many other purposes. Its chief attribute is its power of absorbing greasy matter, which it does in a remarkable degree. There are two kinds of fullers' earth known in commerce, the blue and the yellow. The latter is employed in fulling the finer cloths, while the former is used for the coarser fabrics. Fullers' earth is chiefly composed of silica and alumina, but it is to the latter substance that the earth owes its power to absorb greasy matters.

When the clay is removed from the pits, it is first baked, or dried in the sun, and then thrown into cold water, in which it falls into a fine powder. The finer particles are then separated from the coarser by *washing* (or elutriating, as it is termed in chemical operations). The clay is worked up into a thin paste with water in a large tub. Several such tubs are placed in a row, each of which is connected with the next by means of a spout at the top. A continuous stream of water enters the first tub, and this, overflowing into the other tubs, carries over the finer earth, which is allowed to subside, and is afterwards collected and dried. This is used for cleansing the finer qualities of cloth.

The coarser earth, after being dried, is employed in fulling the coarser kinds of cloth.

Fullers' earth is frequently employed as a healing medium for sores and excoriations, more especially for infants suffering from the effects of careless and slovenly nursing.

FILE-MAKING.

There are two kinds of tool employed in the preliminary process of rendering metals, wood, horn, etc., smooth previous to polishing. These are the *file* and the *rasp*.

The steel from which files and rasps are made must be of the finest quality of cast steel, but the best Lancashire files are made from the best Swedish hoop iron.

Files are either *single* or *double* cut, according to the purpose for which they are required. In the former, a series of sharp edges are cut diagonally across the surface of the steel by means of a sharp-edged chisel. The double cut is given by *cross-cutting*—that is, making a series of cuts at the same angle as the former equally across each cut. The single-cut files are chiefly used for filing brass and copper, while the double-cut files are more suitable for steel, cast iron, and other hard metals. If a double-cut file is used for a soft metal like copper, it is liable to become clogged with this metal, and in a very short time ceases to perform its proper function; and, on the other hand, a single-cut file, if applied to hard metals, as steel, for example, passes over the surface without doing the work required of it.

Files are cut of various degrees of fineness, called respectively rough, bastard cut, second cut, fine cut, and smooth. The large heavy files used by smiths are sometimes even coarser than ordinary "rough" files, and these are called "rubbers." Files are also of various forms, as flat, half-round, three-square, four-sided, and round. Half-round and three-square files are generally tapering, excepting when the latter are required for saw-sharpening, when they are of a prismatic form.

In forging the steel for file-making, it is first made red-hot upon a coke fire, after which it is hammered upon an anvil specially constructed for the purpose, on one end of which is a projection furnished with a hole to receive a tool for cutting the file lengths from the rod of steel. In the anvil there is a deep groove to hold the dies which give the required forms to the files. Flat files are made entirely by hammering. The hot steel bar is held by one workman, who strikes it with a small hammer, while another workman strikes it with a larger hammer. By the wonderful precision with which, by constant practice, this operation is conducted, the surface of the metal is rendered perfectly smooth and flat, a most important point in the art of forging the metal for files of this description.

Half-round files acquire their form by being hammered into a boss or die, which is fastened into the groove in the anvil. The rod is laid on the boss and hammered until it fills the die. The three-sided files are also formed in a die, the recess being two sides of a triangle. The steel rod is first hammered square, and then one angle is placed in the die, and the hammer applied until the three sides are properly formed.

In file-cutting, the chisels employed are somewhat broader than the file; they are sharpened at an angle of about 20°; and the length is such as to enable the file-cutter to hold them conveniently between his thumb and forefinger. The blow of the hammer is given with great precision, and the chisel handled with considerable dexterity, so as to ensure regularity in the cuts with quickness of movement. The file is first laid upon the anvil, one end projecting over its front and the other over its back edge. It is next secured in its position by means of leather

straps, which are furnished with stirrups, to enable the cutter to keep the file in its position by means of his feet. The file is first single cut on one side, and afterwards cross-cut as before mentioned. Before cutting the other side of the file a flat block of soft metal, composed of lead and tin, is placed on the anvil, upon which the file is laid with its cut face downward. The object of this is to prevent the cutting of the first operation from being obliterated by the hard surface of the anvil. When half-round or three-square files are being cut, they are placed in rounded or angular grooves in the soft metal.

Rasps are cut with a triangular punch, which leaves projections all over the surface of the steel of a pyramidal form; and the cuts are made with the utmost uniformity which an experienced workman can accomplish. Indeed the precision and neatness with which the art of file-cutting is practised is highly creditable to those who pursue it with such uniformly good results.

Hardening the files is of the greatest importance, since it is upon this quality that the usefulness and durability of the file mainly depend. If the file, after being cut, were to be made red-hot and thrown into water, in the same way that other steel tools are treated, the oxidation of the metal which accompanies this operation would affect the fine sharpness of the teeth and thereby impair the efficiency of the tool. To prevent the surface of the file from being acted upon by the oxygen of the air, after being made red-hot, it was formerly the custom to coat it first with ale-grounds, and then to cover it with powdered salt. When this coating was dry, the file was made red-hot, hardened, and then brushed over with coke-dust, which gave it a bright metallic lustre as if it had not

been subjected to the fire. An improvement in this system was afterwards introduced, which consists in making a saturated solution of salt, to which ale-grounds are added, and this forms a creamy mixture which readily attaches to the steel. The files are first dipped in this compound, then made red-hot and hardened.

In heating the file it is held by the tang in a pair of tongs, and placed in a forge fire, the fuel employed being small coke. The heating is done gradually, and as uniformly as possible; when of a cherry-red colour, it is quenched in very cold water. Some manufacturers employ sulphuric acid and water for hardening these tools, believing that this increases the hardness of the steel. In plunging the red-hot files into water it is usual to hold them perpendicularly, and to immerse them in the water as quickly as possible, so that the point shall not have time to cool before the stouter parts; by this means warping is prevented. After the hardening is complete the files are brushed over with coke-dust and water, and finally well rinsed, dried, and rubbed over with a mixture of oil and turpentine.

BRONZE.

There is no alloy of metals, taken in its application to purely artistic purposes, which has held such an important position from remote ages up to our own time as that of copper and tin, known by the name of *bronze*. Although made from two such soft metals as those named, the alloy possesses great hardness, and was from this cause employed by the ancients for making swords, hatchets, and various tools, before the manufacture of iron was developed. About

seven hundred years before the Christian era, Theodorus and Ræcus of Samos, according to Pliny, invented the art of modelling in bronze. It had long been known that an alloy of copper and tin was more fusible than copper alone, and that consequently the process of casting was easier, while at the same time an object produced from the alloy was considerably harder. During the reign of Alexander the art of bronze-casting became greatly extended, and a celebrated artist, Lycippus, succeeded in multiplying groups of statues, by new processes, to such an extent that Pliny called them "the mob of Alexander." After this colossal bronzes were produced, of which the isle of Rhodes possessed about a hundred, and the Roman consul Mutanius discovered three thousand bronze statues at Athens, an equal number at Rhodes, Olympia, and Delphi, even after a large number had been removed from the latter city.

The proportions in which copper and tin should be united to form a fusible alloy which will become hard on cooling, without being brittle, has often been the subject of great diversity of opinion. And indeed it is not only the proportion in which the respective metals are combined, but the method adopted in fusing them together that the art of making a good bronze consists. With the same weight of the two metals placed in the hands of different metallurgists, it is more than probable that the resulting alloys would vary considerably. Indeed there are certain judges of "real bronze" who can distinguish at a glance the ancient from the modern bronze, be the latter never so cunningly disguised by artificial means.

Modern bronze is generally made by alloying copper and tin with the addition of a moderate percentage of zinc, or zinc and lead. For bronze which has to be struck into

medals, 92 parts of copper to 8 parts of tin, or 88 parts of copper to 12 parts of tin, are recommended as forming a tough alloy. A finer tint is given to this bronze by the addition of a small percentage of zinc. The bronze from which bells are cast, and which is known as bell-metal, is composed of 78 parts of copper and 22 parts of tin. This forms a very fusible alloy, and yields a rich sonorous tone on being struck by another piece of metal, hence its suitability in bell-founding.

Chinese gongs are made from an alloy of copper and tin only, the gongs being hammered out until very thin. Cymbals are also made from the same alloy, but for these instruments a smaller percentage of tin is employed.

The alloy from which cannons are made, and which is called gun-metal, consists of about 90 parts of copper to 10 of tin. The proportion of tin varies, however, according to the views of the respective founders.

The antique bronze colour is given to modern bronze-work by applying certain substances which more or less affect the surface of the alloy, giving it the appearance of long exposure to the action of the air. The following recipes have been used for this purpose with good effect: 1. Sal-ammoniac, 1 drachm; salt of sorrel, ½ drachm; dissolved in 14 ounces of white vinegar. Warm the bronze slightly, and apply with a camel-hair brush, repeating the operation until the desired tone is obtained. 2. Sal-ammoniac, 1 part; cream of tartar, 3 parts; common salt, 6 parts, dissolved in hot water, 12 parts; add to this solution of nitrate of copper 8 parts, and brush over the surface as before. After a while the bronze becomes covered with a green coat possessing great beauty.

PLAYING CARDS.

As far back as the year 1832, Mr. De La Rue took out a patent for printing playing cards in oil colours. In the old way of printing these cards, certain parts of the design upon the "picture" cards were produced by copper-plate printing, and the other colours were impressed in water colours by means of stencil plates.

There is no doubt that Mr. De La Rue's invention of printing in oil led to Mr. Baxter's subsequent application of oil-printing, which in the present day has been extended to the production of oleographs and chromo-lithographs, many beautiful specimens of which now adorn the windows of the modern printseller. De La Rue's invention consisted first in printing the pips, and also the picture or court cards, in oil colours, by means of blocks or types; second, in effecting the same object in oil colours by means of lithography; and thirdly, gilding or silvering borders or other parts of the characters by the printing process either by types or blocks, or by lithography.

The types or blocks are first used to print the pips representing the various suits; or they are drawn upon stone in the usual way. The ink is applied to the blocks or stone in the same way that printers' ink is ordinarily applied, and the impression taken on thick drawing-paper by means of a press. The picture cards are produced from a series of blocks, each devoted to its own colour. When the required number of impressions of any given colour have been made, the second colour is printed on the surface, then the third, and so on. Each block is made to fit exactly in its proper place, so that the colours cannot interfere with each other during the process of printing. When lithography is

employed in printing playing cards, it is necessary to have as many stones as there are colours used in the printing, and these must be applied with the same exactness as in type or block printing.

The ornamentation on the backs of playing cards, which is sometimes exceedingly chaste and pretty, is produced by a method similar to the above.

IRONFOUNDING.

The art of ironfounding includes many operations within its range, amongst which the most important are—remelting the pig or other cast iron; pattern-making; making the moulds, and moulding, or casting.

Melting the cast iron.—This is generally done in what is called a cupola furnace, capable of melting from 3 to 5 tons of metal at a time. A blowing-machine is employed to assist the fusion of the metal. When the furnace is first lighted, a layer of wood is placed on the bottom, and over this coke is piled, and the wood is then lighted; in a short time after a blast of air is introduced, which hastens the kindling of the fuel. Before the blowing-machine is set going certain apertures in the sides of the furnace are opened in succession, beginning at the lowest; alternate charges of coke and pig-iron are now thrown into the furnace, the iron having been previously broken up into small fragments of not more than about 14 lbs. weight each. The metal begins to melt in about twenty minutes after its introduction, and fresh charges are made about every ten minutes, each charge consisting of from 2 to 3 cwt. of iron. A cupola furnace will melt from 1 to $1\frac{1}{2}$ ton of iron per hour. It is reckoned that 200 lbs.

of coke will melt 1 ton of cast iron after the furnace has got up to its full heat.

When the moulds for receiving the melted metal are formed upon the ground, these are generally placed a few yards from the furnace. When all is ready, a clay plug which stops up the lower opening of the furnace is pierced with an iron rod, and the molten metal then runs out into a gutter which conveys it to the mould; and when this is full, the aperture of the furnace is again closed. When the moulds are very small, or at a considerable distance from the furnace, the melted metal is conveyed by iron pots or ladles lined with loam. These pots are carried by two or more men, according to their weight; or sometimes they are conveyed from the furnace to the mould by means of a crane.

When the iron has cooled in the mould it is taken asunder, and the superfluous metal is removed from the edges of the castings by means of a hammer, the edges being afterwards trimmed with a cold chisel.

Moulds are made with loamy sand, or with a mixture of clay and sand worked up into a paste with water, and cow's hair added to keep the composition together. This mixture is made in a loam-mill worked by steam-power. Moulds are also made with what is called *green sand*—that is, sand as it comes from the pits—mixed with powdered coal, these being worked up together with a little water. Baked sand, or that which has been already used, is also employed for making moulds, and sometimes, for large pieces of work, all three of the moulding materials given are worked up together and give very good results.

Moulding in green sand is carried on as follows: The pattern, which is generally made of wood or iron, is first

prepared. Two iron frames of exactly the same size are used as a box or envelope for the moulds; the longest sides of these frames are united by parallel cross-bars about 6 or 8 inches apart. The two halves of the box have *ears* corresponding exactly with one another. One of these is pierced with holes, while the other has projections which fit into them. This frame is of sufficient size to take the required pattern and the moulding material. When the mould has to be prepared, the two halves of the box are laid side by side on the foundry floor. Green sand is then shovelled into one of the halves until it is full; this is then gently beaten with a rammer. The pattern is now laid upon the level surface of sand, and sufficient pressure given to partially embed it in the sand. The second half of the box is then placed over the first, and this in its turn filled with the green sand, after which the box is reversed, by which the first half becomes uppermost. This is now removed with care and steadiness, and it takes with it the sand which had been pressed into it, but leaves the pattern embedded in the sand of the second half. The moulder now makes good any irregularities in the surface of the mould nearest the pattern, and sprinkles dry and finely-sifted sand over the exposed parts of the pattern. He next breaks up the bed of sand first formed in this frame, then covers the pattern with green sand, and replaces the frame in its former position, so as to re-form the box, and again fills the frame with sand, which he rams as before.

The two halves of the box are now separated and the pattern carefully removed. But before the box is made up again it is necessary to form a series of channels in the sand for the passage of the melted metal, and

several smaller channels leading from the pattern for the escape of air. The box is now made up as before, and the ears secured together by bolts. The melted metal is poured into an orifice in the sand, called the *gate*. When the pattern is very large, several such apertures are made, and the metal is poured into each of these at the same time. Sometimes, before bringing the two halves of the mould together, it is the practice to dust over the two surfaces either with finely-powdered charcoal, contained in a muslin bag, or powdered plumbago.

Moulding with baked sand, or that which has already been used, is conducted in the same way as above, and it is not usual to mix powdered coal with this sand. After the mould is finished, it is placed in a drying-stove, where it is allowed to remain until all the water employed in working up the sand is expelled, after which the mould is baked. Moulds thus prepared are more porous than those made from green sand, and consequently the air has better means of escape, which is very important when large castings are required.

Moulding in loam is performed by making the design in the moulding material from drawings previously prepared, instead of moulding from a pattern.

CAMEL-HAIR PENCILS.

The so-called camel-hair pencil, or brush, is more frequently made with the hair of any other animal than that of the hump-backed denizen of the desert,—the hair of the marten, civet, polecat, and even that of the domesticated mouser, being employed in the fabrication of these useful artists' tools.

The hairs are generally taken from the tail of the animal, and this is first well cleaned by being scoured with a solution of alum, after which it is soaked in warm water for many hours. The tail is then passed through the hand from the base to the tip, so as to free it as far as possible from the water and to lay the hairs down smoothly, after which it is dried with a cloth, and the hairs cut off in clumps close to the skin. These are afterwards set out according to their lengths, and the little bundles are next placed upright in tin pans, with the tips upward, and by a gentle tap upon the tin the hairs become arranged according to their respective lengths. The longer hairs are then separated from the shorter ones, by which means the equal length of the hairs is secured, and upon which the perfection of the pencil depends. Although when spread out flat upon a level surface the hairs of a good pencil, or brush, are of perfectly even lengths, when the tip is moistened and formed into a point by the lips or otherwise, the pencil assumes a tapering form by reason of the outer hairs of the brush becoming bent, or curved, at their points toward the centre hairs, which remain erect.

After the bundles of hair have been levelled as described, a small pinch sufficient to make a brush is taken, and the lower end is tied by a thin thread, after which it is neatly bound by thin silk or thread up to a certain height. The next operation is to select quills of various sizes. These quills are obtained from geese, swans, pigeons, larks, and other small birds, according to the required size of the pencil. These are first cut to the proper length, and then soaked in water for many hours to prevent them from splitting. The brush of hair is then pointed and passed through the wider end of the quill, and is next

gently pressed through the narrow opening by means of a wire. When the softened quill becomes dry it naturally contracts, and thus firmly grips the bundle of hairs enclosed by it.

Instead of employing quills in the manufacture of artists' pencils, it is now commonly the practice to insert the bundles of hair in metallic tubes appropriately tapered, and these are fixed into cedar or other wooden handles, thus forming an exceedingly agreeable tool to work with, and rendering the employment of quill-splitting handles unnecessary except in some instances.

WHITEWASHING.

Custom has made us acquainted with the effect, if not with the method, of whitewashing. In preparing his "whitewash" the workman puts a few lumps of whiting into a bucket, and works it up into a thin creamy mass with the addition of water, taking care to leave no lumps in the mixture. To this is added a moderate amount of size, or thin glue, which is well stirred in and thoroughly incorporated. It is applied to ceilings and walls by means of a broad, flat brush, which should be worked uniformly in one direction. Surfaces that have been previously whitewashed should be first brushed over with a dry brush to remove dust, and afterwards well brushed over with plain clean water; when this surface has become partially, but not wholly dry, it is in a better condition to receive a coating of whitewash.

Lime-washing, as it is termed, consists in brushing over certain surfaces, as stable walls, cattle-pens, etc., with a mixture of *quicklime* in water. Mr. Tegetmeier says:

"Lime-washing is, from the cleansing action of the *quick-lime,* much the more effectual mode of purification, but is less frequently had recourse to, from the general ignorance respecting the proper mode of preparing the lime-wash. If glue is employed, it is destroyed by the corrosive action of the lime, and in consequence the latter easily rubs off the walls when dry. This is the case also if the lime is employed, as is often absurdly recommended, simply slaked in water, and used without any fixing material. Lime-wash is prepared by placing some freshly-burned quicklime in a pail, and pouring on sufficient water to cover it; boiled oil (linseed) should then be immediately added, in the proportion of a pint to a gallon of the wash. For coarser work any common refuse fat may be used instead of the boiled oil. The whole should then be thinned with water to the required consistency, and applied with a brush. Care should be taken not to leave the brush in the lime-wash for any length of time, as it destroys the bristles." In lime-washing, Russia tallow is frequently used in preference to other fatty matters.

THE ART OF LAPIDARY.

The art of cutting and polishing precious stones, as also engraving the same, was known and practised by the ancients. They do not appear, however, to have succeeded in cutting the diamond, and were therefore satisfied to wear it, as an ornament, in its native condition. In 1476 Louis de Berghen discovered that by rubbing two diamonds against each other, these exceedingly hard gems yielded to the mutual attrition, and after this all the finest diamonds were sent to Holland to be cut and polished. As time

progressed, however, the lapidaries of London and Paris succeeded in competing with the Dutch artists, and indeed fully equalling their best efforts.

Gems are cut either by *cleavage*, or by cutting off slices of the gem with fine wire fixed in a stock, with the addition of diamond powder and olive oil. Oriental gems, such as the ruby, topaz, and sapphire, are cut with diamond powder moistened with olive oil, upon a revolving copper wheel. When the facets are thus formed, they are afterwards polished upon a second copper wheel, with tripoli (rotten-stone) and water. Emeralds, amethysts, garnets, agates, and other softer stones are cut, with fine emery and water, at a leaden wheel, being afterwards polished on a tin wheel, with tripoli moistened by water. The more fragile gems are polished on a wheel made of hardwood, assisted by emery and water, and they are afterwards finished on another wooden wheel, with tripoli and water. The diamond is the only precious stone which is cut and polished on a mill-plate of soft steel, by means of diamond powder and olive oil.

Although the diamond is the hardest of all known substances, it may be split by a keen steel tool, to which a smart blow is given, provided the cleavage is attempted in the right direction. It is usual, however, to cut these gems by friction, rather than risk the dubious process of splitting. The rough diamond is first secured to a stick, called the *cement-stick,* upon one end of which is a small ball of cement, the diamond being embedded in the cement, with the exception of the part to be cut, which is allowed to project. A second diamond is then secured in the same manner, and the two stones are rubbed against each other with considerable force, by which two flat surfaces or facets

are produced. By shifting the position of the diamonds, and adopting the same procedure, two other facets are formed; and this system of readjusting the diamonds in the cement, and rubbing the two surfaces or projections together, is continued until the required number of facets are formed, when the stones are ready for polishing. When the cutting of the stones is complete, they are next embedded in soft solder, excepting the facet to be polished, which is allowed to project.

The diamond powder which is produced by the friction of the two diamonds against each other is carefully preserved for use in the after processes of polishing; and those diamonds which are, from some defect or other, incapable of being cut into *brilliants*, or *rose diamonds*, are frequently reduced to powder in a steel mortar, the powder being employed by lapidaries for cutting gems, and for other useful purposes, such as making drills used for piercing holes in rubies for watch movements, and for producing very fine holes in steel plates for fine wire drawing.

"To fashion a rough diamond into a brilliant," Ure says, "the first step is to modify the faces of the original octahedron, so that the plane formed by the junction of the two pyramids shall be an exact square, and the axis of the crystal precisely twice the length of one of the sides of the square. The octahedron being thus rectified, a section is to be made parallel to the common base, or *girdle*, so as to cut off five-eighteenths of the whole height from the upper pyramid, and one-eighteenth from the lower one. The superior and larger plane thus produced is called the *table*, and the inferior and smaller one is called the *collet;* in this state it is termed a *complete square table diamond.* To convert it into a brilliant, two triangular facets are placed on

each side of the table, thus changing it from a square to an octagon; a lozenge-shaped facet is also placed at each of the four corners of the table, and another lozenge extending lengthwise along the whole of each side of the original square of the table, which, with two triangular facets set on the base of each lozenge, completes the whole number of facets on the table-side of the diamond, viz. eight lozenges and twenty-four triangles. On the collet-side are formed four irregular pentagons, alternating with as many irregular lozenges radiating from the collet as a centre, and bordered by sixteen triangular facets adjoining the girdle. The brilliant being thus completed, is set with the table-side uppermost, and the collet-side implanted in the cavity made to receive the diamond. The brilliant is always three times as thick as the rose-diamond. In France the thickness of the brilliant is set off into two unequal portions; one-third is reserved for the upper part, or table, of the diamond, and the remaining two-thirds for the lower part, or collet (*culasse*). The table has eight planes, and its circumference is cut into facets, of which some are triangles and others lozenges. The collet is also cut into facets called *pavillons*. It is of consequence that the *pavillons* lie in the same order as the upper facets, and that they correspond to each other, so that the symmetry be perfect, for otherwise the play of the light would be false.

"Although the rose-diamond projects bright beams of light in more extensive proportion often than the brilliant, yet the latter shows an incomparably greater play, from the difference of its cutting. In executing this there are formed thirty-two faces of different figures, and inclined at different angles all round the table, on the upper side of the stone. On the collet twenty-four other faces are made

round a small table, which converts the *culasse* into a truncated pyramid. These twenty-four facets, like the thirty-two above, are differently inclined, and present different figures. It is essential that the faces of the top and the bottom correspond together in sufficiently exact proportions to multiply the reflections and refractions, so as to produce the colours of the prismatic spectrum."

Artificial stones, or *pastes*, are cut and polished in the same form as brilliants, but, being of softer material, are cut with fine emery powder and water, and polished with tripoli. The French have recently produced artificial gems of such exceeding beauty that the lustre, or "fire," of these stones is nearly equal to that of the brilliant itself. If the tip of the tongue, however, be applied alternately to a real gem and an artificial one, the former will produce a cold sensation, whilst the latter will appear warm by comparison. This is one way of detecting the difference between the two, which is infallible.

FRENCH POLISHING.

The superb brilliancy which is given to furniture and cabinet-work made from rosewood, mahogany, and other choice woods, and the permanent character of the surface produced, when properly treated in use, renders the art of French polishing well worthy of consideration.

The principal material used is a solution of shellac in methylated spirit, or wood naphtha (pyroxylic spirit). Some polishers add gum sandarac, gum elemi, or copal varnish to the above, with a view to toughen the polish.

The polish is prepared in the same way as ordinary spirit varnishes, but with the addition sometimes of a

little colouring matter. To give a warm reddish tinge, dragon's blood or alkanet root may be used; and a yellow tone may be given by mixing a little gamboge or turmeric with the polish. When it is desired to keep the wood light coloured, oxalic acid is commonly added to the polish.

In making the French polish, either of the following recipes may be adopted: 1. Pale shellac, $5\frac{1}{2}$ ounces; wood naphtha, 1 pint. Mix, and shake frequently until the shellac is dissolved. 2. Shellac (dark), 12 ounces; wood naphtha, 1 quart. Dissolve as before, and add linseed oil $\frac{1}{2}$ pint. 3. Shellac, $\frac{1}{2}$ lb.; gum sandarac, $\frac{1}{4}$ lb.; methylated spirit, 1 quart. When the gums are dissolved, add copal varnish $\frac{1}{4}$ pint; mix, and add linseed oil $\frac{1}{2}$ pint. The two latter polishes may be used without applying oil to the rubber.

The practice of French polishing is thus given by Mr. Cooley:—

"This process, now so generally employed for furniture and cabinet-work, is performed as follows: The surface to be operated on being finished off as smoothly as possible with glass-paper, and placed opposite the light, the 'rubber' being made as directed below, and the polish being at hand, and preferably contained in a narrow-necked bottle, the workman moistens the middle of the flat face of the rubber with the polish by laying the rubber on the mouth of the bottle and shaking up the varnish against it, once, by which means the rubber imbibes the proper quantity to cover a considerable extent of surface. He next encloses the rubber in a soft linen cloth, doubled, the rest of the cloth being gathered up at the back of the rubber to form a handle. The face of the linen is now moistened with a little raw linseed oil applied with the finger to the middle

of it, and the operation of polishing immediately commenced. For this purpose the workman passes his rubber quickly and lightly over the surface uniformly in one direction, until the varnish becomes dry, or nearly so, when he again charges his rubber as before, omitting the oil, and repeats the rubbing, until three coats are laid on. He now applies a little oil to the rubber, and two coats more are commonly given. As soon as the coating of varnish has acquired some thickness, he wets the inside of the linen cloth, before applying the varnish, with alcohol, or wood naphtha, and gives a quick, light, and uniform touch over the whole surface. The work is, lastly, carefully gone over with the linen cloth, moistened with a little oil and rectified spirit, or naphtha, without varnish, and rubbed, as before, until dry.

"The rubber for French polishing is made by rolling up a strip of thick woollen cloth (list) which has been torn off, so as to form a soft elastic edge. It should form a coil, from 1 to 3 inches in diameter, according to the size of the work."

ETCHING.

This interesting and beautiful art is simple enough in itself, but like most other pursuits, it requires the efforts of genius to raise it above the level of commonplace. Since this art is at the present time receiving much attention, a short description of the process may not be uninteresting.

Etching is generally performed upon copper, zinc, or steel plates, and the surface of the plate, which must be well polished, is first thinly coated with a prepared varnish, or "etching ground," which may be made as follows: Take of virgin wax and asphaltum, of each 2 ounces;

Burgundy pitch and black pitch, of each $\frac{1}{2}$ ounce. Melt the wax and pitch together in an earthenware pipkin; next reduce the asphaltum to a fine powder, and add this gradually, with stirring, to the former. Boil the whole together until it becomes tough on cooling. This may be ascertained by dropping a little of the varnish from time to time upon a plate, when, if it is tough, without being sticky, it is ready for use. The varnish, when cool, is to be poured into warm water, so that it may be more freely handled, and it is then rolled into balls until required to be used. In melting the ingredients, care must be taken that the heat is not too great, otherwise they may take fire.

The Florentine etching varnish is composed of old linseed oil, 4 ounces, heated in a pipkin; to this is added, with constant stirring, powdered gum mastic, 4 ounces. Pass this mixture through a piece of muslin, and put it into a bottle. The method of using this varnish and blackening it is thus: After well cleaning the plate to be etched, by means of chalk, to remove grease, hold the plate by one corner with a pair of pliers; now hold it over a lamp, or clear fire, and then cover the plate with the varnish, and while the plate is still warm and the varnish liquid dab the plate all over with a ball of cotton tied up in taffety; by this means the varnish becomes equally distributed over the surface. The plate must now be blackened by holding it over the flame of a smoky lamp, by which the tracings of the stylus, or etching-needle, are more easily seen. A bundle of cotton wick dipped in paraffine and ignited will effect this readily. Great care must be taken, while blackening the varnish, not to set it alight.

White or virgin wax and lampblack, applied to a

copper-plate previously made hot, form a very good etching ground for small experimental operations of the student, which is easily manipulated.

A soft etching ground prescribed by Callot consists of linseed oil, 4 ounces; gum benzoin and white wax, of each $\frac{1}{2}$ ounce. These are to be mixed and boiled until reduced to about two-thirds.

A *soft etching ground* may also be made with either lard or tallow spread evenly over the plate.

Having prepared the plate to be etched upon with either of the foregoing preparations—the object of which is to protect the plate from the action of acids used in "biting in" the design, except at those parts which have been traced by the etching-needle or point—the next operation is to employ the stylus, or point, which is done by tracing *through* the varnish so as to leave the metal bare wherever the point has been applied. The picture or design being carefully drawn, it will be necessary, before applying the "biting fluid," to form a border of wax round the edge of the plate, which is easily done by melting a little wax in a pipkin, and when it is cooling, and in a pasty condition, applying it to the edges of the plate with a spatula, or ordinary table knife. This wax border may be from $\frac{1}{4}$ to $\frac{1}{2}$ inch in depth for small plates.

The plate is then to be placed in a horizontal position, and the etching fluid poured on, and allowed to remain for a short time, or until the "high lights" of the picture are sufficiently bitten in. The fluid is then to be poured off, and the plate washed with water, and allowed to dry. The light parts are then to be "stopped out" with Brunswick black or other varnish, and fresh etching fluid poured on as before; this is allowed to act until the finest of the

lines are "bitten" sufficiently deep. The solvent is then again poured off and the plate washed as before, and the same process is repeated until the darkest shadows and lines are bitten in sufficiently. The plate may now be cleaned by being gently warmed, and rubbed with a pad of cotton dipped in turpentine.

The fluids used for biting in, or acting upon the plate, are generally nitrous,* or fuming nitric acid, for copper; nitric acid and pyroligneous acid (wood vinegar) for steel; and hydrochloric acid, or dilute sulphuric acid, for zinc.

The following has been recommended by Turrell for etching upon steel: Pyroligneous acid, 4 parts; alcohol, 1 part; mix, and add nitric acid 1 part.

Callot, the great French artist, employed, for etching copper, verdigris, sea-salt, and sal-ammoniac, of each 4 parts; alum, 1 part; mixed with French vinegar, 8 parts. Afterwards add water 16 parts. The solid substances are first to be well ground and dissolved in the vinegar, and the water then added. The whole is then to be boiled for a few minutes. This mixture is applied to the etched plate after it has been treated with nitric acid, and washed and dried, the object being to deepen and finish the delicate tracings of the etching point.

Etching upon the soft ground prepared from lard or tallow is effected by placing a piece of paper evenly over the surface of the plate; the design is then traced with the needle as usual, by which the fatty matter adheres to the paper wherever the point has been applied, and thus leaves the copper bare; the plate is then treated with acid

* The so-called *nitrous acid* of commerce is a mixture of hyponitric acid gas and nitric acid: it is not nitrous acid.

as before, and the effect, when the plate is printed from, somewhat resembles pencil drawing.

Aquatint is a method of etching upon copper by first sifting powdered asphaltum on the copper-plate previously greased slightly. The loose powder is then shaken off and the plate gently heated. When cool, the lights of the picture are covered with turpentine varnish, mixed with lampblack, by means of a camel-hair pencil. A border of wax is then formed round the plate, and dilute nitric acid is poured on and allowed to remain for five or six minutes; this is then poured off, the plate washed and dried, and the pencil and varnish applied as before. This alternate process of "stopping" and etching is continued until the deepest shadows are produced.

A very ingenious, simple, and expeditious mode of etching upon iron and steel was suggested by Mr. Cooley. "The metal is warmed until it is capable of melting a piece of bees'-wax, or 'etching ground,' which is then carefully rubbed over it so as to form a thin and even coating; when cold, the design is 'scratched in' in the common way; a little powdered iodine is then sprinkled on the exposed parts, and at the same time a few drops of water are added, and the two worked into a liquid paste with a camel-hair pencil. The paste is then moved about over the intended etching for a period varying from one to five minutes, according to the depths of the lines required to be produced. Afterwards the whole is removed and reapplied, etc., as with the usual etching fluids. The same etching paste, by being kept for a few days, again acquires the property of dissolving iron, and may be used again and again; but independently of this, the iodide of iron formed during the process, if rapidly evaporated to dryness in a clean iron vessel

by a moderate heat, and placed in stoppered bottles, will sell for more than the original cost of the iodine. To travellers and amateurs, who amuse themselves with the delightful art of etching, iodine, from its portability and convenience, will doubtless prove invaluable."

Etching on glass is done by employing *hydrofluoric acid* (an acid which has the power of dissolving glass) either in the fluid state or in its gaseous form. The surface of the glass is first covered with the etching ground, and the design is then scratched in, after which liquid hydrofluoric acid is poured on if the design is required to be *transparent;* or the glass is subjected to the fumes of the acid when the design is to be *opaque.* In place of either of the above systems the following will be found a simple way of etching on glass: pour on the plate a sufficient quantity of sulphuric acid (oil of vitriol), and then sprinkle over it finely powdered fluor-spar; chemical action then takes place, by which hydrofluoric acid is set free, and this at once attacks the glass, rendering the surface dull. Since sulphuric acid, however, would destroy almost any etching ground that could be employed, this method should only be adopted when it is desired to render dull the whole surface of a glass plate.

ROTTEN-STONE (TRIPOLI).

This very useful polishing medium is a natural product, originally obtained from Tripoli, in Barbary, from which it derives its name, but which is also found in many other parts of the earth. Rotten-stone is of a yellowish-grey colour, and its particles are impalpably fine, hence its employment for polishing silver, brass, and other metals. When

examined under a powerful microscope, it is found to be composed of the skeletons of *animalculæ;* these are seen with such distinctness that their identity with living species of the same genus is easily recognised, there being no appreciable difference between the petrified and living.

Rotten-stone is found in Derbyshire, Bohemia, France, Corfu, etc., but that which comes from the latter place is considered by some persons as the best for polishing brass and other metals. It is used either with water or oil, more generally with the latter, and is applied either with a leather or a buff-stick—a flat piece of wood having a strip of soft leather glued to it on to one side. In large operations, the polishing is done at a lathe worked by a treadle or by steam-power. After using rotten-stone and oil in the polishing of articles of jewellery or plate, the article is afterwards "finished" by hand or machine with jewellers' rouge. The rouge is moistened with water, and when this is rubbed on the article previously polished with rotten-stone, a brilliant surface is produced with very little labour, and articles of silver, electroplate, gold, and gilt work assume under this treatment the highest degree of brightness which the respective metals are capable of receiving.

LITHOGRAPHY.

This art consists in taking impressions upon paper, from stone, of figures or writing previously traced upon the stone. There are two qualities of lithographic stones, one of which is a hard grey fine-grained limestone obtained from a quarry at Solenhofen in Bavaria, and on the banks of the Danube; the other is a soft stone of a cream or yellow colour. The white *lias* which lies beneath the

blue lias, near Bath, yields good lithographic stone, and it is from this source that the principal stones used in this country are obtained. The ink with which the lines are traced upon the stone is composed of wax, tallow soap, gum-lac, and various other materials, and this adheres firmly to the smoothly polished surface of the stone, and attracts the printing ink from the inking roller, as it is passed with some force over the stone. During the operation of printing, the stone is kept constantly in a damp or moist state, which prevents the adhesion of the ink to those parts of the surface of the stone which are not impregnated with the encaustic ink employed in the process.

A good lithographic stone is of a uniform character throughout, is free from veins, fibres, and spots. The stones are quarried with the aid of a saw, and one side is then roughly smoothed, in which condition they are ready for the market. The stones receive the necessary polishing and finishing at the lithographic establishments in which they are used, as the nature of the surface depends upon the class of work to be printed from the stone. The polishing in large establishments is done by machinery, upon a revolving disc of iron, finely sifted sand and water being employed to assist the grinding or levelling of the stone; this is afterwards finished by hand with "snake," or water-of-Ayr stone. For *crayon drawing* the stone is grained more or less fine, according to the taste of the draughtsman. For very fine work a higher finish is given to the surface, but in this case fewer good impressions can be obtained from the stone. Finely powdered pumice and water are sometimes used to produce a very fine surface for certain purposes.

There are two systems of lithography commonly practised: the first consists in drawing upon the polished stone with a pen or hair pencil with lithographic ink; and in the second the design is drawn on prepared paper, which, being placed on the stone and passed through the press, leaves the design upon the surface of the stone *reversed.* The stone is afterwards acted upon by means of *dilute* acid. For this purpose nitric or hydrochloric acids are mixed with water, and the acid solution poured over the stone and allowed to remain for a short time, until the chalk of the stone has been sufficiently acted upon to leave the tracings or design in relief.

The **smooth stone** is also extensively used for printing transfers from engraved steel or copper plates, taken at the copper-plate press, on prepared paper, with *transfer ink.* This impression is placed on the slightly-heated stone, which is passed through the press, and a *reversed* impression is then left on the stone, from which a large number of copies can be printed.

Reversed drawings are made on the *grained surface* of the *hard stones* by means of lithographic crayons, followed by etching with dilute acid. The relief on the stone is so slight as not to be perceptible. Gum-water is used to fill up the pores of the stone, and to protect the drawing.

Lithographic crayons, as they are termed, must possess certain qualities in order to obtain the finest prints which the art is capable of producing. The crayons must adhere firmly to the stone not only after the acid solution has been applied, but also during the time when the impressions are being taken in the press; they must also be hard enough to allow the most delicate tracings to be made without risk of breaking. MM. Bernard and De La Rue

of Paris adopted the following composition: Pure wax, 4 parts; white curd soap, 2 parts, white tallow, 2 parts; gum-lac, 2 parts; lampblack, 1 part; with, occasionally, 1 part of copal varnish. The wax is first melted by gentle heat, and the gum-lac is then introduced, in small pieces, with constant stirring. The soap is then cut into fine shavings, and added gradually to the above, and the lampblack and copal varnish added when the incorporation of the other ingredients is complete. The heat is then to be continued until the mass has acquired the proper consistence, which is ascertained by placing a little of it on a plate to cool; if brittle on being cut, the boiling operation is discontinued, and after being allowed to repose for a short time, the composition is poured into metal moulds, which should be previously slightly greased.

Another, and more simple composition for the crayon is—dried tallow soap, 6 parts; white wax, 6 parts; lampblack, 1 part. The soap and wax are melted together, and the lampblack afterwards gradually added, with constant stirring.

Lithographic ink may be prepared from either of the following recipes, both of which have been highly approved:—

1. Wax, 16 parts; tallow, and hard tallow soap (curd soap), of each 6 parts; shellac, 12 parts; mastic in tears, 8 parts; Venice turpentine, 1 part; and lampblack, 4 parts. The mastic and shellac are first well ground together, a little turpentine added, and gentle heat applied; the wax and tallow are then to be added, and when all are thoroughly incorporated, the soap, previously cut into shavings, is introduced, followed by the lampblack, and the whole mass well stirred. Gentle heat is applied during the mixing of the

ingredients, and the compound is afterwards set aside to cool a little, and then poured on a cold plate until quite hard; it is then cut into sticks, ready for use.

2. Dried tallow soap, 30 parts; mastic in tears, 30 parts; carbonate of soda, 30 parts; shellac, 150 parts; lampblack, 12 parts. The soap is first melted in a suitable vessel, over a gentle fire, and the lac then added; the soda is next introduced, followed by the mastic, with continual stirring. The heat of a brisk fire is now applied and continued until all the ingredients are well melted; the mass is finally poured into a mould.

The lithographic inks may be applied with a steel pen or a camel-hair pencil; the ink is first rubbed down with water in the same way as Indian ink, till the required depth of colour is obtained. This must be done in a warm apartment, the temperature of which is not less than about 84° Fahr., or the saucer in which the ink is rubbed must be kept warm by being heated over a lamp or otherwise. Only sufficient ink should be rubbed up for present use, as it does not remain fluid for more than a few hours.

An important branch of the art of lithography is termed **Autography**, by which a writing or drawing is transferred *from the paper to the stone,* and the design or writing thus becomes *reversed* on the stone, and subsequent impressions, taken from the latter, reappear in the proper form of the original. This process saves a great deal of labour, for when tracings are made upon the stone direct, they have to be inverted from right to left in order that direct impressions may be obtained. By means of the autographic paper and the transfer, proofs or impressions are obtained exactly corresponding with the direction of the drawing or writing.

Autographic ink requires to be composed of materials of a more *greasy* nature than those used in making lithographic inks. The formula for this ink is—White soap and white wax, of each 100 parts; mutton suet, 30 parts; shellac and mastic, of each 50 parts; lampblack, 30 parts. These ingredients are to be melted and mixed in the same way as lithographic inks.

Lithographic paper.—First lay over the paper three successive coats of a solution of gelatine warmed, then one layer of white starch made into a thin paste. The paper is allowed to dry before each coat is laid on; a sponge is generally employed for this purpose. Lastly lay on a coat of gamboge dissolved in water. When the paper is dry it must be passed through the lithographic press to render it smooth, by which it more readily receives the ink.

Transferring.—After the paper is moistened, the ink becomes transferred from the gamboge very readily, while the starch separates from the gelatine; and if, after removing the paper from the stone, it is placed on a white stone slab, and hot water poured over it, it will reassume its original condition.

When transferring a drawing, writing, or lithographic crayon to the stone, the following conditions must be observed: the transfer-paper must be thin, and the impressions must become detached, or separated, from the paper, and left upon the stone, by the pressure of the lithographic press. When the drawing or writing is thus transferred to the stone, the transfer-paper is removed, and the direct copy obtained from the stone in the ordinary way.

MARBLE CUTTING AND POLISHING.

This beautiful product of nature is not only largely used in our own time for the noble purposes of sculpture and architecture, and for many other ornamental and useful purposes, as mantelpieces, etc., but certain choice varieties were employed by the ancients both in architecture and sculpture. The celebrated Venus de Medici was cut from Parian marble; the Parthenon, Hippodrome, and other principal monuments of Athens were of Pentelic marble, as also the celebrated Elgin Marbles in the British Museum. A marble called *Marmo Greco*, or Greek white marble, was obtained from the island of Scio (or Chio), the scene of the late terrible earthquake. There are columns and altars in Venice made from a transparent white marble called by the Italians *Marmo statuario*, but the quarries from which the marble was obtained are quite unknown. The *white marble of Luni*, on the coast of Tuscany, was preferred by the Greek sculptors to either the Parian or Pentelic marbles. The celebrated *Carrara marble* is of extreme whiteness, though sometimes it is traversed by grey veins, which render it difficult to obtain a large piece free from them. In this marble specimens of rock-crystal are sometimes found, and have received the name of *Carrara diamonds.*

The black marble of the ancients is only to be found in specimens of sculpture, from which it may be inferred that the quarry from which it was obtained was exhausted. The red marble of the ancients is of a blood-red colour, interspersed with white veins. Besides these antique marbles may be mentioned the green antique marble; the red-spotted antique marble; the yellow; grand antique;

the purple antique, and many other varieties of coloured marble.

Of the modern marbles we have the black, and the black-and-white, found in Derbyshire; the variegated marbles of Devonshire, of a reddish, brownish, or greyish colour, veined with white and yellow; the green marble of Anglesea; the white marble of Scotland; the black-and-white marble of Kilkenny, and many other varieties obtained from various counties in the United Kingdom, added to which Italy, Corsica, France, Sicily, Genoa, etc., yield abundant marbles of great beauty and variety of colour.

Cutting and polishing marble.—For cutting marble a saw is used, which consists of a long flat piece of soft iron fitted into a frame such as stonecutters use, while sand and water are continually applied during the operation. Very large slabs of marble are sometimes cut by machinery.

In polishing marble, the surface is first rendered smooth and flat by means of fine sharp sand and water, a rubber of iron being sometimes used for the purpose. A finer sand is then applied in the same way, and a third rubbing is given with still finer sand. After washing the surface of the slab, emery powder of various degrees of fineness is employed, and this is generally worked over the surface by means of a leaden rubber. The final polishing is done with tripoli (rotten-stone), or with jewellers' rouge, coarse linen cloths rolled up into a hard ball being used as rubbers.

BLACKLEAD PENCILS.

The finest plumbago (or *blacklead*, as it is improperly called, there being no lead in its composition) is obtained

chiefly from the mines of Cumberland. Ure gives the following interesting account of the "picking and stealing" practised by the miners at an early period of the working of the Borrowdale mine: "This valuable mineral became so common a subject of robbery about a century ago as to have enriched, it was said, a great many persons living in the neighbourhood. Even the guard stationed over it by the proprietors was of little avail against men infuriated with the love of plunder; since in those days a body of miners broke into the mine by main force, and held possession of it for a considerable time. The treasure is now protected by a strong building, consisting of four rooms upon the ground-floor; and immediately under one of them is the opening, secured by a trap-door, through which alone workmen can enter the interior of the mountain. In this apartment, called the dressing-room, the miners change their ordinary clothes for their working dress, as they come in, and after six hours' post or journey they again change their dress, under the superintendence of the steward, before they are suffered to go out. In the innermost of the four rooms two men are seated at a large table, sorting and dressing the plumbago, who are locked in while at work, and watched by the steward from an adjoining room, who is armed with two blunderbusses. Such formidable apparatus of security is deemed requisite to check the pilfering spirit of the Cumberland mountaineers."

Properly speaking, the best blacklead pencils are made from Cumberland plumbago, which is first calcined in closed vessels at a bright heat, and afterwards cut into long square-shaped pieces, which are then enclosed between two grooved pieces of cedar-wood. But a process of French origin is, we believe, more generally adopted, with certain

modifications, at the present day. This consists in mixing with finely-powdered plumbago a certain amount of very fine clay. The plumbago is first calcined, which adds to its brilliancy and softness, and is then mixed with the clay in certain proportions; for the softer pencils the smallest possible amount of clay is used, but for the harder pencils the proportion is increased according to the hardness required. The proportions of clay and plumbago are variously given, from 2 parts plumbago to 3 parts of clay for the best pencils, or equal parts of each being sometimes adopted. The various degrees of hardness are obtained by calcination at a higher or lower heat.

The method of working the above process may be thus briefly described: The clay is first *washed* (see p. 65) to separate the finest particles, and these are allowed to subside, when they form a soft plastic mass, which is afterwards placed on a linen filter and allowed to dry. The plumbago, being reduced to a fine powder and sifted, is then worked up with the required quantity of clay until a *perfectly uniform* paste is obtained; this mixture is afterwards worked up on a porphyry slab with a muller until it assumes a doughy consistence, when it is rolled up into the form of a ball, and allowed to dry very gradually in moist air.

To mould the pencil material narrow grooves are cut in a smooth board, which is afterwards well saturated with grease. The plumbago paste is now pressed into the groove by means of a palette-knife, and a smooth flat board, also well greased, is placed over this, and the two boards well secured together by clamps. The mould is afterwards subjected to moderate heat, in order to thoroughly dry the composition; it is then taken asunder, and the pencil gently

turned out upon a soft surface. If done with care this will not break, and will be perfectly straight.

When a sufficient number of pencil-lengths have been thus prepared, they must be again subjected to heat, which is done by placing them upright in a crucible, and covering them over with fine sand, or charcoal powder. The crucible being covered by its lid, is then placed in a furnace fire and made red-hot, after which it is withdrawn and set aside to cool. The pencil-pieces are now ready to place in the cedar cases, which are in two semicircular halves, each being grooved from end to end, and the two halves are united by means of glue.

WIRE-DRAWING.

A steel plate, perforated with a series of holes diminishing in size, is first obtained, and this is secured in a vice. The metal to be drawn is first hammered out to about the diameter of the larger hole, and it is then made red-hot, and afterwards allowed to cool, by which it becomes annealed, or softened. One end of the piece of metal is then filed or hammered to enable it to pass through the larger hole of the draw-plate to the extent of about ½ inch; this is next seized in a pair of strong flat pliers, or *draw-tongs*, the inner faces of which are toothed like a file, and by pulling with sufficient force, the metal is drawn through the hole, and becomes extended in length. It is then drawn through the next and smaller hole, by which it becomes again extended. As the wire by this operation becomes considerably hardened, it must be again annealed. It is then passed through each successive hole until reduced to the required thinness. Since steel and iron wire become

ozidized after annealing, the wire should be immersed for a few minutes in a "pickle" made of very dilute sulphuric acid, and afterwards rinsed and dried. Oil must be freely applied to the hole of the draw-plate while the wire is being drawn.

In drawing wire on a large scale a machine called a draw-bench is employed. This consists of a long table fitted with a toothed wheel, rack, and pinion, set in motion by a winch, worked by one or two men; and the regularity of the speed is secured by means of a heavy flywheel. The wire as it passes through the plate is wound off upon a reel, and the speed at which the operation proceeds is regulated according to the ductility of the metal, and the degree of thinness which it has acquired. As the wire becomes thinner the speed is increased. Iron and brass wire $\frac{3}{10}$ of an inch in diameter will bear drawing at the rate of from 12 to 15 inches per second; but when of $\frac{1}{40}$ of an inch they may be drawn at the rate of at least 40 inches per second.

The late Dr. Wollaston, the eminent chemist, succeeded in drawing platinum wire down to $\frac{1}{3000}$ part of an inch, by enclosing platinum wire in a case of silver ten times its own thickness. When this compound wire was drawn out to the extent of $\frac{1}{300}$ of an inch, the silver was removed from the platinum by dissolving it with nitric acid, which has no effect upon platinum, and thus the platinum wire became exposed in its remarkable state of attenuation.

In drawing very thin wires for scientific and other purposes a steel draw-plate is used in which are several jewelled holes. Rubies and sapphires are generally employed for this purpose, and they are first perforated by means of a fine drill and diamond powder. The reason

why jewelled holes are employed in drawing very fine wires is because the steel of the draw-plate becomes worn by frequent use, and thus the holes become larger. In cases, therefore, where uniformity of thickness is of importance the wire can only be depended upon when drawn through such hard substances as the ruby, sapphire, or chrysolite. A silver wire $\frac{33}{1000}$ of an inch in diameter has been drawn out to the extent of 170 miles through a perforated ruby.

The holes in a draw-plate are made with a conical steel punch, by which they assume a tapering form, the larger opening of which is that through which the wire enters, and which may properly be called the back of the plate. When the draw-plate is fixed in the jaws of a vice secured to a bench the metal to be drawn out is passed through the requisite hole at the back, and the projecting point is then gripped in the pliers, and may, if the metal is soft and thin, be drawn through without very great exertion; but it must be done by a very steady, continuous pull, without the least jerking motion. The counter-sunk hole at the back of the plate facilitates the insertion of the wire.

TYPE-FOUNDING.

Type-metal is composed of an alloy of lead 3 parts, and antimony 1 part, melted together several times to ensure uniformity. For smaller types a slight increase in the proportion of antimony is sometimes given in order to make the alloy harder.

The operation of letter-cutting is conducted somewhat after this fashion: A piece of soft steel of suitable size is taken, and with this the letter-cutter proceeds to form a

punch. He first makes a perfectly flat surface on one end, upon which he traces, with ink, or a fine steel point, the form of the letter. He next cuts round the margin of the letter with a graver, and then scoops out the surrounding metal with a sculpter, so as to leave the letter projecting. The edges are afterwards filed up to the proper form. When this is done the punch is hardened and tempered. These punches are used for making the matrix, in which the types are cast. The matrix consists of a piece of brass or copper about $1\frac{1}{2}$ inch long, and the punch is driven into this, by striking it with a hammer, to the depth of about $\frac{1}{8}$ of an inch. The mould consists of a wooden case in two halves lined with steel fitting truly together; at the bottom of this the matrix is placed, and held in its position by a spring. When each letter is cast it becomes loosened by removing the pressure on the spring. The opening at the top of the mould is widened to receive the molten metal.

The type-metal is melted in a furnace, on the top of which the melting-pot is placed, and this is provided with a small ladle for dipping and pouring the metal. The typefounder, holding the mould in his left hand, dips the ladle in the pot, and takes up only sufficient metal to fill his mould. He then pours this into the mould, returns the ladle to the melting-pot, then throws up his left hand, in which is the mould, above his head, with a jerking motion, by which the metal becomes forced into the interstices of the matrix. He then opens the mould, picks out the cast letter, readjusts the mould, and proceeds to fill it again, after rearranging the spring. All these operations are conducted with so much dexterity and precision of movement that a skilled workman can cast five hundred

letters in one hour, or one letter in every eighth part of a minute.

After the types are turned out of the caster's hands, a boy removes them to another table, and breaks off the superfluous metal, which he performs with great rapidity, even to the extent of clearing from three to four thousand types per hour, or even more. The types are next placed in the hands of the "rubber," who takes up each type with the first and fore finger of his right hand, on each of which is a piece of tarred leather. He then briskly rubs each flat side of the type on a hard stone resting on a table. The operation is done very quickly, several thousand types being rubbed in an hour.

After rubbing, the types are taken by a boy, who places them in a line on a shallow frame, with their faces upward; the dresser then polishes the type on each side and afterwards cuts a groove at the bottom, to enable them to stand upright. The types are made accurately of a uniform height, and perfectly symmetrical at all points.

The various types employed in ordinary printing are pica, small pica, longprimer, bourgeois, brevier, minion, nonpareil, diamond, etc. A fount of type consists of small letters, capitals, points, figures, etc., arranged in certain proportions, and each tied up separately. The large letters employed for posters and other large bills are sometimes made of wood.

MANUFACTURE OF NEEDLES.

It will naturally astonish the reader when he is told that a needle, be it ever so diminutive in size, has to pass through about one hundred and twenty operations before it is ready

for sale. The best steel wire is employed, and this is well examined before being used, in order to ascertain that its quality and thickness are uniform. The wire is supplied to the needle manufacturer in coils, one of which is placed, as required, on a large reel, after which it is wound off upon a wheel of peculiar construction. This coil of wire is next cut at two opposite directions by means of shears, by which the wire is converted into lengths of 8 feet. These are afterwards cut by a machine into the required needle-lengths according to the thickness of the wire, and these are then placed in a box ready for the next operation. In one day the machine will cut lengths of wire for producing about eight hundred thousand needles.

The wires when first cut are somewhat bent, and in order to straighten them they are placed, in bundles of five thousand or six thousand, between two iron rings, and are then subjected to pressure in a powerful machine, which renders them perfectly straight in an instant. The wires are next subjected to the pointing process, which is accomplished at a grindstone, about twenty of such stones being generally placed in rows, and driven by steam-power. In pointing the wires, the workman takes up about fifty of the wires between his thumb and forefinger, and presents one end to the grindstone, while with a leathern thumb-piece, as it is called, he presses the points on to the stone, giving them a rotatory motion at the time, which gives the points the proper form. This operation of *roughing down* is conducted without the aid of water, otherwise the metal would rust. By a modern improvement, a machine for rough pointing is so constructed that the injurious effects of steel and stone dust upon the health of the workmen, which the above system involves, is completely obviated.

After the wires are pointed, they are sent to the head-flattener, who sits at a table on which is a block of bright steel about 3 inches square. This workman takes about two dozen needles between his finger and thumb, and spreads them out like a fan, the points being under his thumb. Laying the heads on the block, he takes a small hammer and strikes each of the heads, by which they become flattened. The blow of the hammer having now hardened the flatted heads, they have to be annealed, and then transferred to the piercer, who takes a small punch, and laying the head on an anvil, gives the punch a sharp blow, by which the eye of the needle becomes formed. The needle is then reversed, and the punch applied to the opposite side of the eye. This operation is generally performed by a child; and the eyes are then trimmed by another child, who places the needle on a piece of lead, and then gives it, child-like, another punch in the eye! The operations of piercing and trimming the eyes are performed by children with great alacrity, and it is said that some of them have been known to pierce with their punch a human hair, and to thread it with another!

The eye of the needle is next *grooved,* and the head properly rounded. The groove is formed by means of a small tool, which being struck with a hammer, makes the necessary indentation on both sides. The heads are afterwards rounded with a small file. The grooving of needles is now generally done by means of a lever worked by the foot, at one end of which is a heavy weight carrying a suitable die, which being brought down heavily, forms the grooves at a single blow.

The next operation is called *tempering.* The needles are first placed on an iron plate, which is then inserted in a

furnace, and allowed to remain until they are of a bright red heat, after which they are plunged quickly into a cistern of cold water. The water is then run off the cistern, and the needles placed in a box, in which they are shaken until they become arranged parallel to each other. When hardened, the needles are exceedingly brittle, and therefore require careful handling until they are tempered. The process of tempering varies in different establishments. Sometimes the needles are placed in a large pan with grease, which is then set on a fire and allowed to ignite; when the fatty matter has burned away the needles are sufficiently tempered. Hot sand has also been used for this purpose.

After the needles have been tempered, they require to be examined, in order that the crooked ones may be separated from the straight. In the process of annealing and hardening, but more especially the latter, the needles frequently become very much bent. They are therefore placed on a flat highly-polished slab, which being tilted, allows the straight ones to roll away into a receptacle beneath, while those that are curved, even in the least degree, remain upon the slab. These are afterwards placed aside, to be straightened on an anvil by hammering.

Needle-polishing is performed by first placing about half a million of them, together with sand or emery, in a small canvas bag; this is then bound lightly at each end, and a series of these bags are rolled to and fro upon a wooden table, by aid of suitable pressure, by which the needles and sand or emery are kept constantly in motion, and therefore subjected to considerable friction. A certain quantity of oil is mixed with the grinding material to assist the process of attrition. This operation of polishing is

carried on for about twenty hours, after which the needles are removed from the bags, and covered with sawdust, to absorb the grease which attaches to them. They are next placed in a cask which revolves upon its axis, and which is furnished with a door, through which the needles and sawdust are introduced. When a sufficient charge of needles and sawdust has been placed in the cask, the workman turns a handle, and causes the cask to rotate moderately for some time, after which the needles are turned out, when they are found to be quite bright and clean. A process of winnowing is next applied, by which the sawdust becomes blown away from the needles.

The needles are next placed in a tray, which is gently shaken until they all lie in the same direction; when they are taken up in heaps, by means of a palette-knife and the forefinger. They are next *sorted*—that is, the points are all laid in one direction—and those needles which are defective, or have broken points, are handed to a workman, who repoints those which are broken, and these are then put aside to be sold at a reduced price. Such needles as may have become bent during the polishing process are afterwards straightened on an anvil.

The needles are now ready for the packer, who places about twenty-five of them in each packet, after which the labels are pasted on, and the packets are ready for sale.

BUTTON-MAKING.

The art of button-making includes many different branches of manufacture, each of which is a separate trade. The substances chiefly used are horn, wood, bone, and vulcanite for plain buttons or for those which are

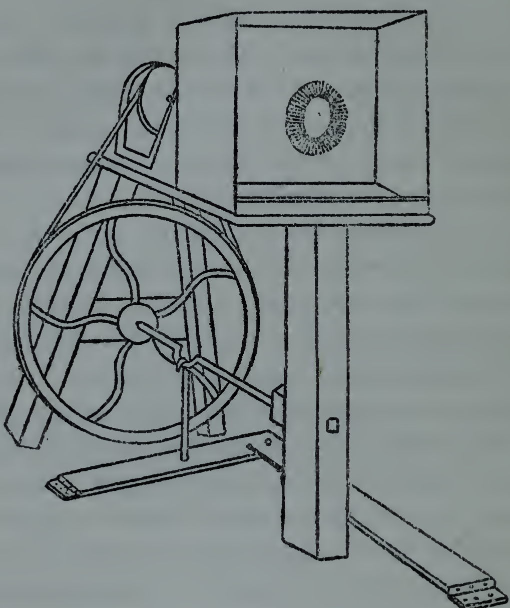
covered with cloth or silk. For the latter class of buttons, discs of bone, horn, or metal are turned or stamped, and these are afterwards covered with cloth, etc. By a recent improvement in the manufacture, the cloth covering is secured by a thin ring of metal, which keeps the cloth from coming unfastened.

Buttons are sometimes made of common brass, pewter, and other cheap alloys. The metal is cast round the shank of the button, by which the latter becomes firmly secured. For casting these buttons a pattern is first made, consisting of some dozens of round buttons, from which a mould is taken; the shanks are then imbedded in one-half of the mould, leaving the ends which are to be inserted in the button projecting. The two halves of the mould being brought together, the melted metal is poured in. When cool, the mould is taken asunder, the buttons removed, and the sand brushed away from them. They are then handed to a workman, who files their edges smooth at a lathe, after which they are finished at another lathe, and the bright parts burnished by passing a bright steel tool over the face of the button. Pewter buttons, such as those worn by policemen, are also cast by a process similar to the above. Mother-o'-pearl buttons are turned at a lathe, the requisite number of holes being made by a drill.

There are many elaborate processes for making buttons by machinery, but it would be impossible in a brief sketch to convey to the reader sufficient information to enable him to understand the apparatus and the modes of applying them.

METAL POLISHING.

When articles of gold, silver, brass, steel, etc., have passed through the various stages of manufacture, their surfaces, or such parts of them as are not required to be left



dead or *matted*, are either burnished (see p. 163) or polished. This latter operation we will now endeavour to describe.

Polishing silver surfaces.—Silver work is always made as smooth as possible by the silversmith before it is placed in the hands of the polisher. After filing, smooth filing, rubbing with emery-cloth of various degrees of fineness, and a final rubbing with water-of-Ayr stone

wetted with water, the silver work is ready for polishing, which, when the work is large, is performed at a lathe, fitted with a box to collect the silver which becomes removed by the polishing material, which is generally rotten-stone and oil. The accompanying sketch represents the ordinary form of lathe. The principal tools employed by the polisher are a series of circular brushes and "bobs," as they are called, and which consist of circular pieces of wood, round the circumference of which a strip of soft leather is attached by means of glue, forming, as it were, a leathern tyre to the wooden wheel. Bobs are also made from various kinds of leather, as bull-neck, cowhide, etc. They are of various sizes and degrees of thickness to suit the varied forms of the articles to be polished; and it not unfrequently happens that the polisher, who is always provided with a stock of leather, has to leave off polishing an article to cut out a bob of suitable size to fit into some hollow or scroll in a new design.

The polishing is effected by means of rotten-stone, or tripoli, moistened with oil; and for convenience in working the former is commonly placed in a shallow vessel, and the oil kept in a conical tin can with a small tubular opening at the top; by gently pressing upon the bottom of the can with the thumb the oil escapes slowly, so that a single drop may be applied if necessary. The lathe being set in motion, the polisher applies a little rotten-stone and oil to the bob he has selected for use, and then presses the article to be polished with moderate force against it, shifting the article continually until the whole surface is gone over. The work is carefully examined from time to time, and when completed is sent into the finishing-room, where it is first cleansed by washing in warm soap and water, with

addition of a little soda, and after well rinsing and drying it is ready for the finisher.

Finishing is performed either at a lathe or by hand. In the former case a mop, or "dolly," is made from a fabric called swansdown, several layers of which, cut into a circular form, are united by means of discs of wood or metal placed on each side and secured by screws or rivets. A hole is formed in the centre to fit the screw of the lathe-head. The material employed for finishing silver work is jewellers' rouge of the finest quality, which is made into a paste with water, and applied, a little at a time, with the finger to the face of the dolly, which must revolve at a very high speed, whether the lathe is worked by the foot or by steam power.

Hand-finishing, or colouring, as it is generally termed, although not so extensively adopted as it was some few years ago, is a very important and delicate operation, and is practised chiefly by men, who require to have a remarkably soft hand, or "velvet hand," as it is called in the trade. The colourer provides himself with a shallow vessel, into which he puts his rouge, and then pours sufficient water on it to give it a pasty consistence; dipping the tip of his finger in this from time to time, he smears the rouge-paste over the part to be polished, and then, with the large muscle of the hand below the thumb, and the side of the hand below the little finger, he rubs the piece briskly, and with moderate pressure at first, which he diminishes as the work progresses. When the surface of the silver has acquired the deep black lustre for which this metal is remarkable when highly polished, it is examined in order to ascertain if there are any scratches or imperfections on the surface. It is absolutely necessary that no particles of dust or grit should get

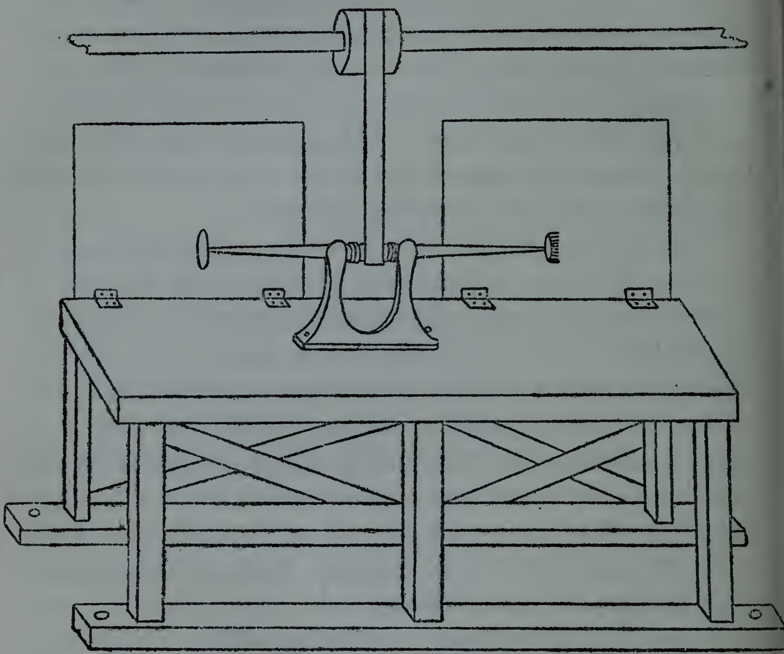
either into the rouge-pot or upon the work while it is being finished. After the articles are coloured the rouge which remains in the crevices is washed out by means of a soft brush and warm soap and water; the work is then wiped with soft old diaper, or linen cloths, or chamois leather, kept specially for the purpose.

Electro-plated goods, but more especially spoons and forks, and articles of a similar description, are sometimes polished by the above system; but this can only be done with plated ware of the best quality, otherwise the lathe-polishing with rotten-stone would soon penetrate the coating of silver, and expose the metal upon which it was deposited by the electro-plating process.

Small articles of silver may be easily polished by means of the buff stick—a flat piece of wood with a strip of chamois or buff leather glued on to it—with the aid of rotten-stone and oil, and afterwards finishing by rubbing the article with a chamois leather and a little dry rouge. In fact, jewellers' rouge is unquestionably the very best substance known for brightening silver and plated goods even after they have been a long time in use. The practice of cleaning plate with a brush and whiting is absurd, while the employment of common plate-powders is too often fraught with considerable risk.

Brass polishing and finishing.—These operations are performed at a lathe set in motion by steam power. It is commonly the practice for brass polishers to fix up their lathes in workshops supplied with steam power from adjacent works, by which the cost of the power becomes very moderate for each lathe. The polishing lathe (see engraving) is a stout bench set firmly in the floor. In its centre is a powerful cast-iron standard securely bolted to the

bench, in which a long double spindle is supported, which works in brass or gun-metal bearings. In the centre of the spindle are two pulleys, one fast and the other loose, by means of which it may be set in motion or stopped in a moment. A band or belt connected to a revolving shaft above passes over either of these pulleys, and the workman,



by means of a short stick, is thus enabled to set in motion or stop the revolution of the spindles at will. This is a very important arrangement, since these lathes are generally worked by two men, one at each end of the spindle; and when either of these requires to change one "bob" for another, which happens very frequently, he takes up the

short stick and pushes the belt from the *fast* pulley, which is attached *to* the spindle, to the *loose* pulley, which runs freely *over* the spindle.

The materials chiefly used in brass *polishing* are glass-cutters' sand and Trent sand; the former, having a sharper cut than the latter, is generally used for very rough work, such as that which comes direct from the founders with visible marks of the file upon the surface. The bobs used in brass polishing are made from walrus-hide, bull-neck leather, etc.

Before proceeding to his work, the polisher takes off his coat and hat and envelopes himself in a long garment—we were going to say robe—of the pinafore type, which fits close to the neck, has long sleeves, and reaches to his feet. Owing to the dusty and dirty nature of his occupation this garb is essential to the polisher, who never attempts to work without it.

When preparing for work, the polisher spreads a square piece of calico on the bench immediately under the point of each spindle, upon which he deposits a quantity of the sand he intends to use. He then takes the piece of work in his right hand, takes up a handful of sand with his left, and, holding the piece up to, and pressing it against the revolving bob with both hands, he cleverly manages to let the sand in his left hand continually escape, by which it passes on to the bob while the work is being pressed against it. The instant the handful of sand is paid out he takes up another handful almost involuntarily, and this movement, acquired by practice, is so quick that a fresh handful is taken up every few seconds. In the process of *sanding*, as this operation is called, the labour is sometimes very considerable, as the workmen are compelled to lean

almost with their whole weight upon the work in order to obliterate the deeper file-marks and other irregularities from the surface.

The first, or *rough-sanding,* operation is usually performed by a workman stationed at the right-hand spindle, and it is afterwards treated by the polisher on the left, who goes over the surface with old sand, or that which has been much used, and which produces a smoother surface.

Brass finishing is frequently done with the aid of quicklime reduced to a fine powder, and sifted through fine muslin. The lime preferred for this purpose is obtained from the neighbourhood of Sheffield, and is well known in the polishing trade as "Sheffield lime." The lime is selected from the kilns by persons who know the requirements of the trade, and is sent in casks or barrels to the London polishers, who preserve it from contact with the air by keeping it in olive jars or large tin chests carefully covered up. When required for use a few lumps are removed from the jar; these are first scraped to remove coarse impurities from the surface, after which they are broken in small pieces, and these are afterwards pulverized in an iron mortar. The powder is next passed through a fine hair sieve or muslin, when it is ready for use. Only sufficient lime is thus treated for immediate working, as it loses its *cutting* properties by exposure in the air.

In **lime finishing** the operation is conducted by a superior workman, and much of the beauty of the work depends upon the care and skill with which this is performed. The lime is applied, with a little oil, to the bobs; and being worked over and over again during the operation, it becomes impregnated with the particles of metal which it has removed from the work, and this increases its polishing

power. It may be well to state here that it is not the polishing medium, whether it be lime, rouge, or other substance, which gives the brilliancy to a metal surface; it is *the metal which becomes removed from the surface* of the work which actually effects the object.

After having gone over the work very carefully, and examined it, the finisher removes the lime-bob from the spindle and fixes a dolly in its place. The dolly for this purpose is made of many layers of unbleached calico, cut into a circular form, and braced together by discs of leather or metal secured by rivets. A hole is made in the centre to admit the point of the spindle. Dry lime is used with the dolly, and the combined effects of this and the frayed edges of the cloth produce an exceedingly fine surface upon the work.

Some brass finishers have recently employed jewellers' rouge in place of lime; and although this article is more costly, the rapidity with which it finishes the work, together with the superior colour which it is capable of giving to brass, renders it preferable to lime.

Steel polishing.—The articles are first ground by a grindstone, or emery-wheel, and are afterwards *glazed,* as it is termed. This consists in submitting the steel goods to the action of round discs of wood covered with leather or metal (an alloy of lead and tin), and applied with emery-powder of various degrees of fineness, moistened with oil. After the surface of the steel work has been rendered as smooth and bright as it is capable of becoming by the above means, it receives a final polish with buffs charged with powdered crocus (peroxide of iron).

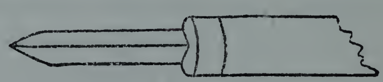
Small steel articles may readily be made bright by first buffing them with fine emery-powder and oil, and afterwards buffing with dry crocus powder.

Zinc polishing is most readily effected by means of rotten-stone and oil in the first instance, and then finishing with dry jewellers' rouge.

MAKING SMALL TOOLS.

There are so many small tools which an amateur may require for some immediate purpose, and which may not be readily procurable, that a few hints upon a ready method of making them may not be unacceptable.

A scraper.—Take an old three-square file and place it in the fire until red-hot, allow it to cool gradually, when it will have become softened. Now file it to the form of the



sketch, leaving the three cutting faces at the top with sharp edges. After smooth filing rub the three faces upon emery-cloth slightly oiled until they are perfectly smooth. Next wipe off the oil, hold the tool by its tang in a pair of pliers, and place about one inch of the top in the hottest part of a clear fire; when at a bright heat withdraw it from the fire, and plunge instantly into cold water. Pass a file over the face to ascertain that it is hard, and then proceed to temper it, but before doing so again rub the three faces of the point on the emery-cloth, so as to render them perfectly clean. Now hold the point of the tool in the pliers, and place the tang end in the fire for a few moments, then withdraw it, and observe the variations of colour which proceed upward from the heated part, commencing with blue,

and passing on to orange, and finally a pale straw colour. When this latter tint has reached the extreme point of the tool it may be dipped in water. It is now tempered, and may be sharpened upon an oilstone, but in doing this care must be taken to preserve the proper form of the instrument and to sharpen the edges *uniformly*. Before rubbing on the stone the tang should be fixed into a short straight handle such as is used for a bradawl. This tool is very useful for reducing and rendering metal surfaces smooth by scraping.

Small chisels may be very readily made from old flat files, softened and filed up to the proper shape, and afterwards hardened and tempered. It will be necessary, however, in order to obtain a perfectly flat and smooth surface, more especially on the under surface of the chisel to obliterate all the teeth marks of the file, otherwise the instrument will not give a clean cut when finished. The best plan is to render the entire surface of the old file fairly smooth all over, and then to give it a more perfect finish from the point to about an inch below by rubbing it upon emery-cloth, a piece of stone wetted with water, or still better, by grinding on an ordinary grindstone. The face of the chisel should now be formed by filing the end obliquely, as in common chisels, after which the tool may be hardened and tempered as above described, the pale straw or orange temper being the point at which the heat should be checked. After tempering, the chisel may be fixed in a handle, and should then be well rubbed all over with emery-cloth slightly oiled, which may be conveniently applied by folding the emery-cloth over a piece of flat wood. The edge of the chisel is now to be sharpened upon an oil-stone, and the tool is ready for use. Flat steel rods suitable

for making very small chisels may be obtained from the metal warehouses.

Steel gouges may be made from old half-round files, smoothed up as above, a hollow groove is then to be filed at the end *on the flat side,* and the cutting edge filed into a semicircular form. When this is properly done, and the tool, after hardening and tempering, is sharpened upon the oilstone, it should be capable of making a clean semicircular cut.

Small punches may be made from round steel rod. Cut off about a three-inch length and file the point to the required size, taking care to let the form of the tool taper gradually toward the point; now file a flat face on the point corresponding with the size of the hole required. After making the point smooth with emery-cloth, harden and temper the punch about half-way from the point, leaving the opposite end soft. A pale orange temper will do well for small punches.

Small drills are very readily made. Take a piece of round steel of smaller diameter than that of the required hole to be formed by it, and about $2\frac{1}{2}$ inches long. Make one end red-hot in the flame of a lamp or candle, and then, laying it on an anvil, or any flat surface of iron or steel, flatten the point by one or two steady blows from a small hammer. Next file the point into a triangular form (see engraving), leaving an oblique face on each opposite side

Now make the point, only, red-hot, and dip into cold water, or the fat of a candle. After rubbing on emery-cloth to

clean the surface, temper cautiously by gently heating the drill about an inch from the point, and when the straw tint reaches this dip into cold water at once. The two faces of the drill may now be rubbed on the oilstone until the edges become sufficiently sharp. For very fine drills, needles, previously annealed and treated as above, will be found very useful.

For cutting small pieces of metal, a useful little saw may be quickly made as follows: Cut a thin strip, about $\frac{1}{2}$ an inch in width, and 4 inches long, from a steel busk, or a piece of clock-spring will answer admirably. Now take a strip of sheet brass, German silver, or stout sheet tin, of the same length, and about $\frac{3}{4}$ of an inch wide, and turn it up, lengthwise, until the two edges meet. This may be very conveniently done by first cutting a nick or groove in a piece of wood with a tenon saw about $\frac{3}{8}$ inch deep; if one half of the flat sheet brass be placed in this groove, a little pressure upon the other half and hammering will bend it at a right angle. Now remove the metal, and bring the two edges *nearly* together by hammering, after which place the strip of steel in the opening, and hammer the brass until the steel blade is firmly set. If the edge of the steel be now roughened by cross-cuts made with the edge of a fine file along its entire length, the tool will cut small pieces of metal with perfect ease. Jewellers call this tool an *carring saw.* Suppose we desire to make a series of small brass rings, for example, we take a piece of wire of the required thickness, and coil it round an iron rod, or mandrel, by fixing one end of the wire and a piece of iron rod in a vice, and then winding the wire tightly round until sufficient coils are given. If we now cut each of

these coils with the earring saw, we shall obtain so many rings, that is, a ring for each cut.

Small steel burnishers are easily made from flat steel rod forged to the proper shape, then filed smooth, rounded at the upper end, or face, and afterwards rubbed upon emery-cloth until a perfectly smooth face is obtained. The tool must then be hardened, and tempered very carefully to a pale straw, so as to leave the face as hard as possible without being brittle. The face must now be rubbed on an oilstone, taking care to preserve its rounded form, and finally polished on a buff, first with crocus, and afterwards with rouge.

GOLD BRONZE.

This elegant preparation of fine gold, which is so much used in illuminating, and for other artistic purposes, is obtained by triturating gold leaf with gum water in a pestle and mortar. The mucilage of gum should not be too thin, and the trituration should be kept up until a perfectly homogeneous mass is formed, in which the particles of gold, which have a rich metallic lustre, become reduced to an impalpable powder. Gold shells are prepared by being painted over with this composition. If it is desired to obtain the gold in the form of a powder, or bronze, boiling water should be poured into the above mass with stirring, and after a while the gold will become deposited, when the water may be poured off, and fresh hot water added to wash out all the gum. When dry, a delicate gold bronze is the result.

Dutch gold bronze may be prepared in the same way by substituting Dutch-leaf for the fine gold leaf.

Silver bronze, from which silver shells may be prepared, is obtained in the same way as above, by rubbing up silver leaf with the gum water.

When dry bronze powders are required, the leaf metal may be triturated with honey or molasses instead of gum water, and this is afterwards washed out by hot water as before.

Gold bronze may also be prepared *chemically*, that is, by precipitating gold from its chloride solution by means of solution of sulphate of iron. A brown deposit of pure gold is formed, which after washing and drying is afterwards triturated with honey or gum water.

A so-called silver bronze is produced by melting bismuth and tin, 1 ounce of each, and then adding mercury from 1 ounce to 1½ ounce. When cold reduce to a powder with pestle and mortar. The Dutch-gold bronze and the last-named "silver" bronze are used by japanners, makers of plaster casts, etc.

BURNISHING.

The art of burnishing silver, electro-plate, and gilt work, is chiefly pursued by females, many of whom attain great proficiency, and execute their work with admirable skill; and although there are innumerable tools of varied forms employed in finishing a single article, we have known burnishers who could accomplish the task of burnishing a large plain (that is, not engraved or chased) surface—as a salver, for example—with such delicacy of finish that it was impossible to detect on the bright plain surface any trace of the tool marks. This is the perfection of burnishing.

The tools employed in burnishing are very numerous, and are made of steel for the preliminary operations of

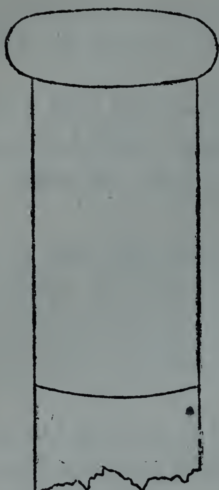
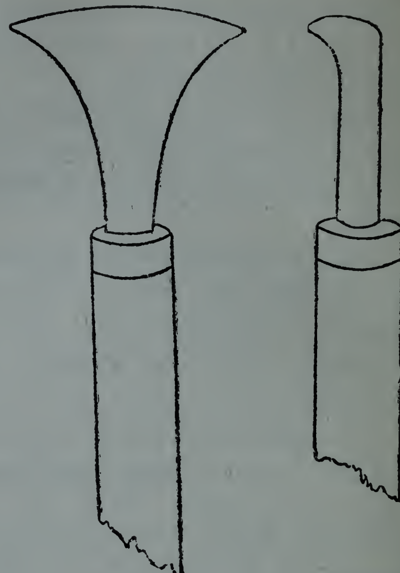
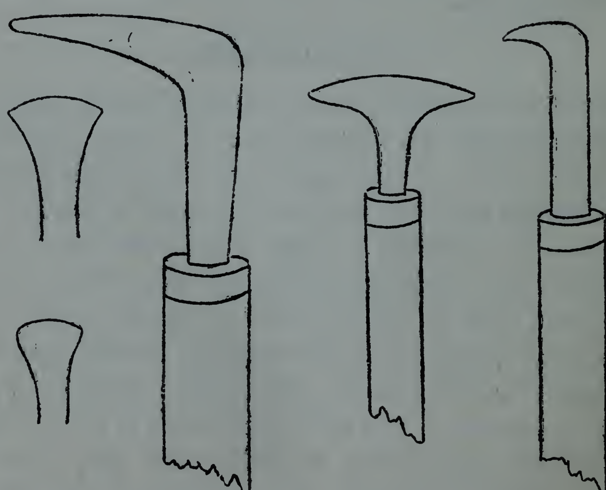


FIG. A.





grounding, as it is called, and bloodstone for *finishing.* The engravings will convey some idea of the forms of a few of the tools, and render a brief description of their use more easily understood. Fig. A represents a bloodstone burnisher, and the other illustrations represent various forms of the steel burnisher.

The bloodstone is set into an iron tube, slightly flattened at one end, by means of soft solder; a short wooden haft or handle is inserted in the other end of the tube, and may be firmly secured by being fixed in with a little fine plaster of Paris made into a thin paste with gum water.

Steel burnishers are fixed into wooden handles, fitted with a ferrule to prevent the wood from splitting.

Before using the steel tools they are rubbed upon a *buff* with the aid of jewellers' rouge. The buff is a piece of leather such as is used for soldiers' belts, about 8 inches long and 2 inches in width. The leather is first boiled for some time in water, after which it is dried as quickly as possible, by which it becomes very hard; it is next attached to a stout flat board about ½ an inch larger than itself each way. A heavy weight, or clamps, are used to flatten the buff-leather and to secure its uniform adhesion to the board. When thoroughly dry, the burnisher proceeds to form a groove from end to end of the buff by rubbing one of the tools upon the surface, and leaning with all her weight upon it so as to form as deep a groove or hollow as possible. Into this groove a little jewellers' rouge is placed, and the burnishing tool is then rubbed to and fro until the face of the tool has a bright black lustre. It is commonly the practice to make several grooves in the same buff used for steel tools, so that the thin and stout ones may each be rubbed in

the track suitable to their calibre. In rubbing the tools upon the buff the burnisher uses considerable pressure, by which a very brilliant surface is imparted to the face, and upon which the beauty of the burnishing greatly depends.

The buffs for bloodstone burnishers are made in the same way as the above, but the groove or channel must correspond with the thickness of the instrument, which in some cases is nearly $\frac{1}{4}$th of an inch; whereas the stoutest steel burnisher seldom exceeds $\frac{1}{16}$ inch in thickness. The material used for producing a highly-polished face on the bloodstone is putty powder (oxide of tin), which is applied in the same way as rouge for the steel burnishers.

In preparing silver or plated work for burnishing it is first scoured all over with fine silver sand, and warm soap and water applied with a piece of soft flannel, after which it is thoroughly well rinsed in warm water, and then wiped dry with a soft diaper or old linen rag. The burnisher then prepares a small quantity of warm soapsuds in a gallipot or other convenient vessel, which she places on the table near her right hand. Having selected one of the burnishing tools and rubbed it on the buff, she dips it in the soap and water, holding it in her hand with the handle resting on the little finger near the knuckle, and under the first, second, and third fingers, while the thumb rests upon the top of the haft or handle; by this means the tool is held firmly in the hand, and can be used with the necessary force. The continued pressure upon the lower joint of the little finger produces an extensive corn. The first tool used is one of the larger and thinner burnishers, and this is held in a slanting direction on the work, and passed backwards and forwards with moderate pressure until the whole

surface has been gone over; the tool requires to be rubbed upon the buff occasionally, and is dipped in the suds every few moments. The next tool employed is stouter than the first, by using which the marks left by the former become considerably obliterated. After going over the surface once or twice more with steel tools of different degrees of thickness the bloodstone is applied, which, having a broad, smooth face, enables the burnisher to remove almost all traces of the tool marks left by the preceding implements. The surface is finally burnished with what is called the finishing-stone, which is a piece of bloodstone of the finest possible quality.

Burnishing gold and gilt work is performed much in the same way as silver burnishing, but some workwomen employ vinegar or ale in preference to soapsuds for moistening their tools.

In burnishing chased or engraved work, but more especially the former, great care is necessary to avoid letting the tools slip over the matted surfaces, as the slightest scratch upon the delicate frosted surface would be a great disfigurement to the whole piece of work.

In burnishing small articles of jewellery, such as rings, brooches, pin-stems, etc., a very small tool is used, resembling in shape and size the "stiletto," or piercer, used in making eyelet holes in linen.

Steel burnishing is generally performed by a long oval tool, with a handle at each end. The instrument is held in both hands, and rubbed over the work with considerable pressure. Common brass work is burnished after a similar fashion.

WALL-PAPERS.

It is believed that the Chinese were the first to practise the art of wall-paper making, and it was not until a comparatively recent period that the English and French nations sought to imitate the productions of the Chinese. The method of ornamenting the paper was originally done by *stencilling*. Certain designs were cut out in pasteboard; and this being laid upon the paper, the required water or distemper colour was brushed over the pattern, by which the paper became painted. This design being now removed, the colour was allowed to dry, when another pattern was applied in the same way. By skilful arrangement of subjects very satisfactory results were sometimes obtained. The ornamentation of the walls of apartments was extensively practised in this country before the art of manufacturing wall-paper became developed. We remember examining the walls of the old Essex House at Putney on the eve of its demolition some few years ago. It was formerly the residence of the Earl of Essex of Elizabethan memory. The walls, which had been partially shattered by the ruthless hand of the "housebreaker," gave evidence of having been coated from time to time by various systems of ornamentation, including the art of stencilling, of which there were some rude examples visible when the upper layers of modern plaster were removed.

After a while the slow method of stencilling wall-papers was abandoned, and the block-printing system of the calico-printer was adopted. The blocks were made of pear-tree or sycamore, or of poplar, faced with either of the former, and upon this the design was cut. A separate

block is required for each colour, or shade, and for an ordinary flower-pattern paper at least ten or a dozen blocks are required.

The colours employed in printing wall-papers are—for *whites,* whiting with or without white lead; *reds,* decoction of Brazil wood, etc.; *blues,* Prussian blue or blue verditer; *yellows,* chrome yellow, Persian berries, yellow ochre, etc.; *greens,* mixtures of blues and yellows, and (too frequently!) the highly poisonous Scheele's green, a compound of copper and arsenic, as deadly a poison as the most suicidal fanatic could wish his bedroom to be adorned by. *Browns* are made with umbers; *blacks* with bone-black, lampblack, etc.; *violets* with blue and red, or from a decoction of logwood and alum. The colours are mixed up to a certain consistence with size or weak glue, and sometimes thickened with starch.

Laying the ground is the first operation, and this is done by brushing over the surface of the paper, previously laid out flat, a coating of suitable colour; the pieces thus treated are then hung up to dry. When thoroughly dry the grounded paper is laid on a perfectly smooth table, with the colour downward, and the back of the paper rubbed with a brass polisher, by which the painted surface is rendered smooth.

In printing the paper the same kind of apparatus is adopted as for calico-printing, namely, a swimming tub is employed, from which the workman takes off the colour upon his block, and transfers it to the grounded side of the paper. A pin is fixed at each corner of the block, which enables the printer to apply it with uniformity. The calf-skin drum-head — which floats over water thickened with paper shavings instead of colour, as

in calico-printing—is brushed over with the required colour by a boy, and the workman then places his block upon the surface, which takes up a sufficient amount of the paste. To give additional power to his arm the workman employs a lever, which acts upon the back of the block. After each impression is made the paper is pulled forward by the boy over a wooden trestle. As each piece is printed with one colour it is hung upon rollers situated near the ceiling, and left to dry. The printer usually devotes one day for printing each colour, so as to give time for drying. When all the colours have been printed the workman examines each piece, and makes good any defects by applying small brushes dipped in the respective pigments.

Flock-papers, as they are termed, are prepared somewhat thus: The flocks are obtained, as refuse, from the woollen cloth-makers, being the clippings removed by the shearing-machine. The flocks are first cleansed, and then dyed the required colour; they are next dried in a proper mill, and afterwards ground to powder and sifted, by which the flocks of various degrees of fineness are separated The flock is used after the other colours have been impressed upon the paper. The flock powders are kept in a long box with a hinged lid, the bottom of which, called *the drum,* is covered with vellum. This box stands on four legs, about two feet from the floor.

The block for flock-printing has the design cut in relief, which is destined to receive an adhesive mixture formed with boiled linseed oil and white lead. When the block, previously coated with this *mordant,* has been applied to a portion of the paper, the assistant boy draws the paper through the flock-chest, and sprinkles it all over with the

flock powder, after which the lid is closed, and the lad beats upon the skin so as to cause the flock-dust to rise, and thus cover uniformly the prepared surfaces of the paper. When this is done he strikes the back of the paper gently to shake off the loose particles of flock powder. To give the proper gradations of tone to flock-papers, as in all other kinds of block-printing, the material employed has various shades of colour, each of which is laid on in the same way, separate flocks, of course, being used for each shade.

The mordant used for the above is also employed for gilding certain parts of the pattern, but the gold leaf is not applied until the mordant is nearly dry; and the superfluous gold leaf is afterwards brushed off with cotton wool when the size is absolutely dry.

Wall-papers are now extensively printed by means of the cylinder printing machine; but as the principle is the same as in block-printing, probably the little information given may be sufficient for the reader.

MATCHES.

The advance from the old "brimstone match" to the present neat little phosphorous-tipped "lucifer" was not effected by a single stride. In the early part of the present century many attempts were made to find a substitute for the "flint, steel, and tinder box," which furnished the only means of ignition for the brimstone-tipped match of the time. But it was not until the year 1826 that the first step in the right direction was made. This consisted in first dipping strips of cardboard or thin pieces of wood in melted sulphur, and afterwards in a mixture

of sulphuret of antimony and chlorate of potash. To ignite these matches they were drawn through glass-paper. This was undoubtedly an important invention, and clearly led up to all the subsequent improvements. Another invention somewhat in vogue for a time consisted in tipping small wooden splints with a composition containing chlorate of potash, and this was ignited by touching the cork of a small bottle filled with oil of vitriol. It was not however, until the "Congreve light" or "lucifer" match was introduced that the comfort of an instantaneous light-producing match was experienced. About this time "C. Keatch's Congreve matches" were freely sold at threepence per box, and the doom of the brimstone match was sealed.

Before describing, briefly, the manufacture of lucifer matches at the present day, it may interest the youthful reader to know how his forefathers obtained a light by means of the once famous old brimstone match, a "counterfeit presentment" of which is sometimes placed in the hand of the annual Guy Fawkes—his effigy. A small round tin or iron box, furnished with a circular iron damper, with a knob for a handle, and which fitted loosely into the box, constituted the "tinder-box." A piece of rag was partially burned, and placed in the box, and the damper placed over it, which, while extinguishing the fire, left the tinder in a condition to become readily ignited by a spark. A piece of steel, with a hook at each end to form a handle, and a large piece of flintstone, completed the apparatus, if we may dignify it by the title. To obtain a light, the lid or damper was first removed from the box; and the steel, being held in the left hand over the box, was struck by the flint held in the right hand until the

sparks thus produced ignited the tinder. If the operator were equally skilful and lucky, this object might be gained at a single stroke; but under less favourable conditions it was quite possible, after bruising his knuckles against the steel a dozen times, that his patience might be rewarded by beholding the long-looked-for spark at the wrong end of half an hour. Having obtained the welcome spark, the next thing was to watch it with intense interest and anxiety. If it were a good spark, it dropped upon a part of the tinder where it would soon grow bigger by a little puff of the breath; but if it chanced to select a less favoured spot, out it went, and the flint and steel were brought into play again. When the spark performed its proper functions, a few puffs of the breath set the tinder well alight, when the point of a brimstone match was applied, and this becoming lighted, brought rapture to the heart of the patient operator. After lighting his oil-lamp or rushlight, the damper was carefully placed over the burning tinder to extinguish it, and thus leave it in good condition for another day.

The timber from which matches are made is the best quality of pine, which is dried at a temperature of about 400° Fahr., and is afterwards cut by machinery into splints of a certain thickness, and in lengths to form two matches; so that when each end has been dipped in the composition, and the splint afterwards cut in half, two matches are formed. Sometimes the wood, instead of being cut square, as in ordinary English matches, is drawn like wire through steel plates furnished with round holes, by which the matches acquire a cylindrical form. Before dipping the splints in either of the compositions given on next page, the ends are held against a hot plate for an instant, by which they

become slightly charred, which enables them to burn more freely.

A shallow vessel, containing melted sulphur, being at hand, the ends of the splints are first dipped in this, and afterwards in the igniting composition. Some manufacturers dip the ends in melted wax or paraffin, which renders the matches less offensive when ignited than those dipped in sulphur. In order to dip a number of matches at one time in the composition, they are arranged between two grooved boards, with the ends projecting a convenient distance for dipping. The composition is spread on a smooth stone, heated underneath by steam, and the ends are then dipped in this, after which the splints are cut in half, and the matches are now complete and ready for boxing. It is usual to put about one hundred matches in each box.

The igniting material varies in different countries and in different manufactories, but the following are amongst the most useful:—

English matches are generally made from fine glue, 2 parts, soaked in water till quite soft; to this is added water 4 parts, heated by means of a water bath until quite fluid, and at a temperature of about 212° Fahr. The vessel is then removed from the fire, and phosphorus, 1½ to 2 parts, is gradually added, the mixture being agitated briskly and continually with a stirrer having wooden pegs or bristles projecting at its lower end. When a uniform emulsion is obtained, chlorate of potassa, 4 to 5 parts; powdered glass, 3 to 4 parts; and red lead, smalts, or other colouring matter, in powder, are added cautiously to prevent accident, and the stirring continued until the mixture is comparatively cool.

Silent matches.—Dissolve gum arabic, 16 parts, in the least possible quantity of water, add of powdered phosphorous 9 parts, and mix by trituration, then add nitre 14 parts, vermilion or binoxide of manganese 16 parts, and form the whole into a paste, as directed above; into this the matches are to be dipped, and then exposed to dry. Or, glue, 6 parts, is soaked in a little cold water for twenty-four hours, after which it is liquefied by trituration in a heated mortar; phosphorus, 4 parts, is now added, and rubbed down at a heat not exceeding 150° Fahr.; powdered nitre, 10 parts, is next mixed in, and afterwards red ochre, 5 parts; and smalts, 2 parts, are further added, and the whole formed into a uniform paste, into which the matches are dipped as before.

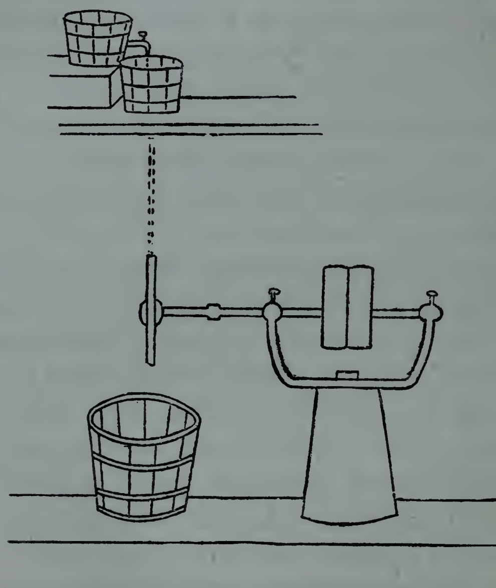
Safety matches.—The chief improvement of note in the manufacture of matches is that of Landstrom, of Jönkoping, in Sweden, adopted by Messrs. Bryant and May. It consists in dividing the ingredients of the match mixture into two separate compositions, one being placed on the ends of the splints as usual, and the other, which contains the phosphorous, being spread in a thin layer upon the sides of the box. The following are the compositions: *For the splints,* chlorate of potassa, 6 parts; sulphuret of antimony, 2 or 3 parts; glue, 1 part. *For the box,* amorphous phosphorous, 10 parts; sulphuret of antimony or peroxide of manganese, 8 parts; glue, 3 to 6 parts, spread thinly upon the surface, which has been previously made rough by a coating of glue and fine emery.

By thus dividing the composition, the danger arising from accidental ignition is avoided, as neither the material on the splint nor that on the box can be ignited by rubbing against an unprepared surface.

Wax-matches, or "vestas," are short lengths of wax-coated cotton, dipped in the composition, which is coloured blue or brown, according to the taste of the manufacturer.

GLASS-CUTTING.

The art of grinding and cutting glass is performed at a lathe, which is generally set in motion by water or steam



power. It is seldom applied to any other species of glass than that which is called "crystal" or flint glass.

The lathe is a simple contrivance, consisting of a spindle running in iron standards fixed to a strong wooden support. A fast and loose pulley in the centre of the spindle for the

driving belt, and a disc of iron attached to the end of the spindle complete the simple apparatus. The iron disc is supplied with sand and water from above by two tubs placed one above another. The upper tub, which is filled with water, is furnished with a tap, which being turned on allows the water to flow into the lower tub, containing sand. This tub, being perforated at the bottom, conveys the sand and water to the face of the iron disc, while a third vessel beneath it collects the sand and water as it flows.

In grinding crystal glass, the iron disc first used is about twelve inches wide, and about one-sixth of an inch in thickness; against this the cutter holds the glass with moderate pressure; after cutting the necessary grooves and facets, a thinner disc is placed on the spindle, with which he proceeds to cut smaller surfaces. The parts thus roughly cut are afterwards made smooth by means of a disc of sandstone and water. The cutter next polishes the work by means of a wooden disc, finely-powdered pumice and water, and finally uses a wooden disc, edged with felt, with the aid of putty powder or rouge. These different stages of the process are generally practised by separate workmen, whereby the trouble of shifting the discs is avoided.

Lenses for optical purposes are always ground in a spherical form, and are either convex or concave; they are placed in moulds either of brass or lead before being ground, by which the proper form of the lens is ensured. The moulds are made in two halves, which are united by a plate at the back fitted with a screw. The moulds are a little smaller than the lens, which enables them to hold the latter firmly. The glass is first ground with coarse emery moistened with water, which is washed off when

the lens has acquired its proper form, and fine emery is substituted, which in time removes the markings produced by the coarser emery. At this stage of the grinding the lens has a uniformly dull surface. The operation of polishing in part is next pursued with pumice-powder and water. While the grinding process is going on the lens is frequently turned, in order that its form may exactly correspond with the mould.

Before the polishing of the lens is attempted, an impression of the mould is taken with a composition made of equal parts of pitch and rosin melted together. The concave mould is now heated, and the melted composition poured in, sufficient to cover the whole surface to the depth of about a quarter of an inch. The cutter next places the cold convex mould into the soft pitch, and gently presses it, by which a perfect impression of the lens is obtained. The mould and lens are next placed in cold water until the pitch is hard. The glass is now polished upon the pitch mould by means of jewellers' rouge and water until the surface is perfectly bright.

Spectacle glasses and small lenses are generally ground and polished in groups in a mould about six inches in diameter. The glasses are fixed in a row, by means of the pitch composition, upon a plate of brass corresponding with the shape of the mould. The glasses are then all ground and polished together as if they were one piece of glass. These glasses are also ground and polished by machinery in very large establishments.

LEATHER-CURRYING.

After the skins of animals have passed through the

hands of the tanner, they require to undergo the process of *dressing*, or currying, to render the leather suitable to the purposes of the shoemaker, harness-maker, etc. The leather is first softened by dipping in water and beating it with a wooden mallet upon a kind of hurdle made of wicker-work. The mallet, or "mace," has a handle about thirty inches long, and on each face of the head are four egg-shaped pegs of hard wood. With this tool the workman beats the leather until it is soft and pliable, after which it is subjected to the process of *cleaning*. This operation is performed upon a wooden plank, supported at its centre by a trestle, while its lower end rests in a strong grooved frame which keeps the plank in an oblique position. Upon the upper end of the plank the leather is placed, and the

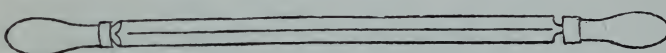


Fig. 1.

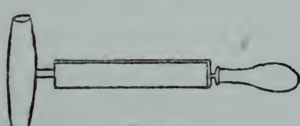


Fig. 2.

workman then takes the two-handled knives (figs. 1 and 2) alternately and scrapes or shaves the flesh side of the leather, in order to smooth and level all inequalities. The leather

Fig. 3.

is then again soaked in water, and well scoured *on the grain side* with pumice stone.

A tool called a "pommel" (fig. 3) is next employed. This is made of hard wood, about a foot in length, and about five inches broad, being flat on its upper surface, and rounded beneath. The under surface is furnished with a series of sharp-edged triangular grooves, cut transversely. On the flat or upper side is a leathern strap, through which the hand is passed when the tool is used. The workman first rubs the flesh side of the leather with the pommel, and afterwards applies it to the grain side, by which it becomes very soft and flexible.

The leather is now rendered uniform in thickness by being scraped with the two-handled tool (fig. 2), the blade of which he keeps in an almost perpendicular direction. After this, he takes a circular knife having a hole in its centre to admit the hand, and with this he scrapes the flesh side of the leather for the purpose of removing all coarse fleshy fibre from the skin. The handling of this tool requires great skill, and upon its dexterous application much of the beauty of the leather depends.

Having thus rendered the skin soft and flexible, it is next rubbed over with a substance called *dubbin,* which is made by boiling sheepskins in fish oil. It is afterwards rubbed over with tallow on the flesh side, and smoothed with a piece of glass. The grain side is then brushed over with a composition of oil and lampblack, called "black on the grain," and afterwards a solution of copperas is applied, and the surface is rubbed over with an iron tool called a "slicker." The leather is now rubbed over with oil, and then set aside to dry, after which it is *seasoned,* that is, brushed over with a solution of copperas on the grain side until the surface becomes quite black. It is next "slicked" with a coarse stone to remove wrinkles and to smooth the grain.

The pommel is again applied in different directions, by which the desired "grain" is imparted to the surface.

Leather may be dyed or stained by brushing over its surface any strong liquid dye, either in the cold state, or when moderately warm. The skin should be first stretched on a board, the dye then brushed over uniformly, and when this has become dry, white of egg is applied to the surface, and it is finished off with the aid of a smoothing stick. Bookbinders employ a solution of copperas to produce a *black stain* or "sprinkle;" a solution of indigo for a *blue stain;* and carbonate of potash or soda for a *brown stain.*

Speaking of leather, Dr. Campbell says: "If we look abroad on the instruments of husbandry, on the implements used in most of the mechanic trades, on the structure of a multitude of engines and machines; or if we contemplate at home the necessary parts of our clothing—breeches, shoes, boots, gloves—or the furniture of our houses, the books on our shelves, the harness of our horses, or even the substance of our carriages, what do we see but instances of human industry exerted upon leather? What an aptitude has this *single* material in a variety of circumstances for the relief of our necessities, and supplying conveniences in every state and stage of life! Without it, or even without it in the plenty we have it, to what difficulties should we be exposed!"

Patent leather, as it is called, is produced by a process of japanning or varnishing. The leather is first freed from every trace of grease upon its grain side, and the surface is then carefully shaved, smoothed, and polished by suitable tools. The varnish is applied to the flesh side of the leather, and the japanning material on the grain side.

After applying the varnish, etc., the leather is placed in a stove moderately heated; the japanned side is then polished, again coated, dried, and polished, the process being repeated several times until the requisite brilliancy is obtained.

JEWELLERY.

It will be readily understood that in a work of this nature it would not be possible, even if it were desirable, which is doubtless not the case, to give more than a brief description of the principal features of this interesting and ingenious art. It is hoped, however, that even the moderate amount of information given will prove interesting to the reader.

The first consideration of the working jeweller is to obtain certain alloys of gold to suit the quality of work he is required to produce. There are eight principal alloys employed in the manufacture of jewellery, the first of which is the 22-carat* alloy, and which is used in the manufacture of wedding rings more especially. This is the only alloy allowed to be hall-marked for this article in England and Scotland. There being no compulsory hall-marking in Ireland, however, wedding rings are frequently manufactured from an inferior alloy. The next important alloy is the 20-carat, which is used for the best descriptions of cast jewellery rings wherein stones of a soft or fragile nature are to be set, such as emeralds, opals, turquoises, etc., owing to this alloy being exceed-

* In *assaying*, that is, estimating, the proportion of gold in an alloy, a *carat* is a weight of 12 grains. The term is applied to the number or parts of *pure gold* in 24 parts of alloy, pure gold being spoken of as "24 carats fine." In diamond weighing a carat represents 4 grains.

ingly soft and ductile, and easily pressed over the edges of the stones.

The casting of articles from the 20-carat alloy is thus performed: A pattern of wood, lead, or other metal is made precisely the same as the article required. A quantity of sand of the finest description is then rubbed up with a sufficient quantity of beer to render it adhesive. One half of a "flask"* is then laid on a board, and the pattern also placed on the board in the centre of the flask; finely-powdered charcoal is then shaken over the pattern and the board to prevent the sand from adhering; the sand is then shaken on the pattern until it forms a cone. A heavy piece of wood is used to hammer or compress the sand till it becomes quite hard. The flask is next removed from the board, which has formed a flat surface of the sand in which the pattern is buried. The sand is then removed or scraped away to the depth of half the pattern, which is thus relieved, and will fall out of the sand on being gently tapped; this will also remove any superfluous sand which may have bound the pattern to the mould. The pattern is next replaced in the impression, and charcoal again shaken on the surface as before, to prevent the fresh sand from adhering. The second half of the flask is then put to the first, and sand again shaken and hammered until quite hard. The flask is then separated, the pattern removed, a channel for the metal is now cut to the gate, and small vents, or scratches, made to permit the expulsion of air when the fused metal is poured in. The sand in the flask is next dried or baked, and both

* A flask consists of two square rims of cast iron made to fit together with pegs, so that they may open and close exactly, and with an aperture at the top, called the "gate," to admit the fused metal.

surfaces smoked over an oil or gas flame, and finally put into a wooden clam or vice made for the purpose. The alloyed gold, previously fused to a white heat, is to be poured in at the gate, care being taken that a sufficient amount of metal is used not only to cast the article, but so much that by its superabundant weight it will force the metal down to the very bottom of the mould. The casting is then as perfect as the pattern, and very little trouble will render it fit for sale. The method described applies only to solid articles, which are not made so often as they are professed to be.

The 18-carat alloy is used in the manufacture of watch-cases, filagree-jewellery, brooches, and many other articles. It is an exceedingly important alloy, many of the finest articles of jewellery being made from it. In order to impart to the work made from this alloy the rich colour of fine gold, a process called "colouring" is adopted, which will be presently explained. Before the work is coloured it is filed up to the proper form, after which it is annealed, and then thrown into a weak solution of sulphuric acid (1 part acid to 10 parts water). The acid solution dissolves the oxide of copper from the surface of the alloy. The article is next well rubbed all over with water-of-Ayr stone, dipped in water, to remove the file marks; it is afterwards rendered smooth by rubbing it with a buff charged with rotten-stone and oil, which readily removes the marks of the stone. It is then cleaned with turpentine to remove the grease, after which it is polished with jewellers' rouge. It is now again annealed, and allowed to cool spontaneously, so that the surface may become oxidised (that is, the copper and silver of the alloy), after which it is ready to be *coloured.* For this purpose a

mixture is made consisting of nitre 8 parts; alum and common salt, of each 4 parts. These are all put into a crucible, and subjected to the heat of a brisk fire: when the fumes at first given off are dispelled, and the salts are properly fused, the work to be coloured (being suspended by a platinum wire) is placed in the fused mass and rapidly agitated for a few seconds, then plunged into a weak solution of hot nitric acid and water (1 part acid and 24 parts water). The acid solution dissolves the salts from the surface, leaving the work a fine gold colour, and as bright as when first placed in the crucible. The effect of this colouring process is, that the combined salts dissolve *from the surface* of the alloy the gold and silver, leaving the pure gold only visible. This is called the "dry-colouring" process.

The 16-carat alloy is generally used for the manufacture of chains, bracelets, and indeed most of the articles retailed under the name of *fine gold.* It used formerly to be employed for the light gossamer work called *filagree-work.* The 15-carat alloy is employed as a substitute for the former, the chief difference being that it is lighter and exhibits a larger surface for its weight. This and the 16-carat alloy are coloured by what is termed the "wet-colour" process, which consists in adding water to the mixture of nitre, alum, and salt, and boiling the gold articles in it until they have acquired the colour of fine gold. The 15-carat alloy is the lowest standard that will bear colouring.

"Chasing gold," or "bright fine gold," as it is called by Scotch and Irish jewellers, is a 14-carat alloy, and work made from it is never coloured, but is polished and finished with rouge. It is a hard and tough alloy, and is used for making stems of pins and spectacle frames, and sometimes

curb and other chains; brooches are also occasionally made from it.

One of the most popular alloys of gold is the 12-carat alloy, familiarly known as "jewellers' gold." It is of a deep red colour, is soft and ductile, and is much employed by goldsmiths as a metal for general use. Articles made from it are put together by means of *silver solder*, whereas with the former alloys *gold solder* is always used. For the method of applying silver solder the reader is referred to page 93.

The lowest legitimate alloy of gold * is the 10-carat alloy, and it is, like the 15-carat alloy, frequently used by not over scrupulous manufacturers as a substitute for a better material. It is very soft and ductile, is easily worked, and many articles of jewellery are made from it.

The next and last alloy worthy of consideration is one in which brass enters into the more respectable society of gold, silver, and copper. One ounce of gold and 1 ounce of brass, with 7 dwts. 8 grs. of silver, and 2 dwts. 16 grs. of copper, make 2½ ounces of 9-carat alloy. It is a clever combination, and possesses several important points of advantage—to the manufacturer. In colour it is equal to 15 or even 16 carat bright gold; it is very light, and consequently an article made from it seems "a good deal for the money;" and it can readily be palmed upon the unwary as "genuine superfine," or "real" gold, according to the fancy of the vendor. This alloy is much used for solid cast rings, since a ring made from it looks as well as one that would cost more for material alone than the entire cost of workmanship and material combined if this alloy be employed. Thus many advantages and induce-

* That is, a mixture of gold, silver, and copper.

ments are held out to workmen and manufacturers to substitute it for the legitimate alloys, which to a great extent it counterfeits admirably.

It is probably well known that nitric acid, or aquafortis, is the test employed by jewellers and others to determine, first, if an article is made of gold; and second, the character or quality of the alloy. Any alloy between 14 and 8 carats will assume a certain appearance when the acid is applied, which gives an idea to the experienced eye of its quality and consequent value. An alloy above 14 carats, unless a very large proportion of copper be present, will exhibit *no* change when nitric acid is applied to it, or even above the 9-carat alloy; but below 8 carat, or if the article be not of gold or any alloy of gold, the surface of the object tested by a drop of nitric acid turns green. In applying this test it is commonly the practice to rub the article upon a hard stone, and then to apply a drop of acid to the fraction of metal thus removed; this can be done without injuring the article. But with all its advantages the nitric-acid test is not infallible, as we will now demonstrate.

Acting somewhat on the principle of modern naval warfare, by which a ship is rendered impregnable by armour plating one day, to be followed on the next by a new gun that will riddle it like pasteboard, the cunning manufacturer, having secured a faithful test for gold in nitric acid, set his wits to work to discover an alloy which would baffle it. It had long been known to science that platinum, alloyed with copper and zinc in certain proportions, formed a substance resembling gold in colour, but unfortunately the alloy was not malleable enough for practical purposes; it was soon found out, however, that by adding a small pro-

portion of silver it became as ductile as an alloy of gold.

Having treated of the alloys of gold used in manufacturing articles of jewellery, etc., our next consideration is the important substitute for gold known in the trade * as "plated work," and which forms a considerable proportion of the articles sold and worn as gold. Albert chains, brooches, rings, lockets, and a host of articles are made from gold-plating of various qualities. The way in which this is made may be thus described. The Birmingham platers take a piece of yellow brass, about an inch thick, and of any required length and breadth; this is first *planished*—that is, hammered flat and smooth—and its upper surface is then filed until perfectly clean and bright, when it is next brushed over with a paste made with powdered borax and water. A piece of gold, the thickness of which depends upon the quality of plating required, is then attached to the brass by means of iron clamps. The two metals thus confined are now placed in a furnace, and the heat continued until the gold, or alloy of gold, as the case may be, becomes fused or "sweated" to the brass. The metal is then promptly withdrawn from the fire, and allowed to cool, after which the iron clamps are removed. The united plates of gold and brass are now immersed in dilute sulphuric acid for a short time, then rinsed in water, and afterwards scoured with sand. The metal is next rolled between two steel rollers, with occasional annealing, until it is of the required thinness, when it is ready for use, and is employed much in the same way as if it were all one metal, care being taken, however, to keep the "best side uppermost," as in most things. It will be

* We wish we could say by the public also.

evident that the opportunities which this process presents of plating brass with an exceedingly small amount of the precious metal would not be lost upon workmen of an ingenious turn of mind with a conscience to match; so we often have examples of gold-plated ware which, for the want of a better simile, we might compare to a very large cup of tea with a very small lump of sugar, in it! Plated articles of this description after a few weeks' wear disclose the baser metal at the edges and prominent points—a very ordinary peculiarity in the worst class of "Brummagem" jewellery.

The London gold-plated ware, which is made by *jewellers*, and not by *platers*, as in Birmingham, generally consists of *a stout layer of inferior gold*, whereas the latter employ *a thin layer of a better quality of gold*. The system adopted by the London jewellers is to *solder* the two metals together instead of "sweating" them; which is done by fusing silver solder between the two metals, by which a perfect junction is formed, and the gold is kept at a respectful distance from the underlying metal. The workman takes a piece of gold about $\frac{1}{16}$th of an inch in thickness, of any required size; and having cleaned it on one side, he takes a piece of brass of the same superficial surface, and $\frac{1}{8}$th of an inch thick, the face of which he renders clean by scraping or filing, and then coats it with the borax paste. He then takes a thin strip or sheet of silver solder of the same size, which, after being well cleaned, is covered with borax. These three sheets of metal are then placed between two stout iron plates tightly bound together to prevent warping (the solder, of course, being placed between the gold and brass), and the whole submitted to the flame of a powerful blowpipe

until the solder, being the most fusible, "runs" or melts, and the operation is complete. After cooling, the sheet is rolled out to the required thinness. Plated metal thus prepared is of so good a character from the stoutness of its gold coating that it may almost be used for the same purposes as gold itself.

In manufacturing articles from gold-plated metal much care is needed to prevent the brass from being perceptible when the article is finished. In order to bring any two edges of the work together so as to form a perfect junction, and present only a gold surface, the underlying brass has to be filed away at the inner angles of each junction, so that when the article is put together, and properly finished, even experienced workmen may find it difficult to determine whether the work is made of gold or plated metal.

Another and very extensively practised branch of cheap jewellery manufacture consists in what is called "struck" work. Thin sheet gold alloy of various qualities is *struck* by means of a die into any desired form, by which a *hollow shell* is obtained; this is then filled by fusing into it a quantity of silver solder. A corresponding half of the pattern is treated in the same way; and the two halves, being brought together and secured in their position by means of binding wire (thin iron wire), a blow-pipe flame is applied until the solder runs, when the union is at once complete, the resulting article having the appearance of solid gold. The old-fashioned watch-seals were made upon this plan, and doubtless by their ponderousness led their owners to believe that with the seals they carried much value about their persons. In the course of time, however, the friction arising from constant use would wear through the layer of gold, leaving the silver lining

exposed to view. Inferior seals and rings were very commonly made upon the above plan, that is, *struck*, and pewter solder employed instead of silver solder for filling the hollow shell of gold.

Mr. Cooley gives the following particulars concerning the Hall-marking of gold and silver:—

"The *Hall Mark* (proper) denotes the place of manufacture or assay, being an anchor for *Birmingham;* a dagger, or three wheat sheaves, for *Chester;* Hibernia, for *Dublin;* castle and lion, for *Edinburgh;* castle with two wings, for *Exeter;* tree and salmon with a ring in its mouth, for *Glasgow;* leopard's head, for *London;* three castles, for *Newcastle-on-Tyne;* a crown, for *Sheffield;* and five lions' heads and a cross, for *York.*

"The *Duty Mark* is the head of the sovereign, showing that the duty is paid.

"The *Date Mark* is a letter of the alphabet, which varies every year, and with the different companies. Thus, the *Goldsmiths' Company of London* have used from 1716 to 1755, Roman capital letters; from 1756 to 1775, small Roman letters; from 1776 to 1795, old English letters; from 1796 to 1815, Roman capital letters, from A to U, omitting J; from 1816 to 1835, small Roman letters, a to u, omitting j; from 1836, old English letters.

"The *Standard Mark* for *gold* is, for *England*, a lion passant; *Edinburgh*, a thistle; *Glasgow*, a lion rampant; *Ireland*, a harp crowned. For *silver*, a figure of Britannia. If under 22 carats, gold has the figures 18."

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